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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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Increased Exports Needed

There is a general awakening to the realisation that the country's export trade must be increased. It has been stressed in all the chairmen's addresses to the annual meetings of shareholders of the large banks and by Presidents of the Chambers of Commerce. The Prime Minister has promised the subject his personal attention. The two main objects sought from such a drive are the creation of additional foreign exchange with which to finance the extraordinary purchases of food and war materials, and effectually to prevent a corresponding action by Germany. Sir Cecil M. Weir, President of the Glasgow Chamber of Commerce, has pointed out the overwhelming importance of creating in neutral countries that attitude of mind which makes support of the Allied cause an easy matter for neutral peoples. Cut off as they are from a remunerative and substantial trade with several European markets—and particularly with Germany—they will bear their losses much more cheerfully if they can replace from the British export market those goods which their people need and the sources of which are not so numerous as in peacetime.

Sir Granville Gibson, M.P., in his Presidential Address to the Leeds Chamber of Commerce, rightly stressed that the Government have special knowledge and responsibility in this matter of exports, as they know which currencies we require, and which therefore must be supported by way of trade. Thus the Government can give concrete instructions and advice as to the parts which each individual firm can play in the strengthening of our wartime economic policy. Sir Granville even suggested that it would be of little moment if a trifling subsidy had to be accorded in order to secure a substantial increase in our supplies of foreign exchange.

It seems to be part of the policy of the Chambers of Commerce to press the Government to appoint a Minister in the War Cabinet with wide powers to co-ordinate the trade efforts of the country. He should be in a position to insist upon priority of imports if such goods are essential for the production of exportable merchandise. On the other hand, Sir William Beveridge, with a wealth of experience of Government "Controls," strongly opposed such a step. Sir R. Noton Barclay, chairman of the District Bank, suggested that the normal peacetime policy of restricting the import of finished goods whilst encouraging that of raw materials should be reversed, and such things as aircraft and armaments should be imported so as to release some British labour for the all-important export trades. He suggested the need for a simpler and more direct control of exports, something on the lines of military operations with an economic C.-in-C.

At the National Provincial Bank meeting, Mr. Colin F. Campbell referred to the price factor in foreign trade and urged the Government to make every effort to prevent a continuing rise in manufacturing prices. Lord Wardington reminded the shareholders of Lloyds Bank of the unique opportunity which now exists of gaining fresh markets for our exports owing to the fact that Germany is largely cut off from her former trading grounds. Mr. Rupert Becket, at the Westminster Bank meeting, made a similar suggestion, and referred particularly to South America. In this connection we would remind our readers of the very substantial trade which Germany has carried on in the last few years with Venezuela in the supply of enamelled goods. It may be presumed that she was interested in the oilfields of that country. What type of enamelled ware was exported we are unaware, but it did head the list of exports of this commodity from Germany. Mr. Becket expressed himself quite optimistically on the future of the export trade, despite the effort being made in the armaments field.

How can the ironfoundry industry best participate in this drive? It still possesses a large reserve capacity and the necessary labour. Where foundries are attached to engineering concerns, naturally as a department they can do little on the commercial side, but the light-castings branch and the pipe foundries control their own destiny. They should maintain the closest contact with the appropriate Government Departments, for advice and help in meeting the market needs of countries formerly filled by Germany, especially (as Mr. Becket pointed out) South America. Undoubtedly, during the last war, by the repatriation of capital, we lost much ground here to the Americans, whilst these losses have since been made worse in recent years by German Government export subsidies. This has also been a factor in the Near Eastern markets for baths and other light castings, and if these markets are now called upon to pay an economic price, the fact that subsidies have been given in recent years should be brought home to them by enlightened propaganda.

C

A Successful Safety-First Effort

When a firm has enjoyed an exceptionally good accident record for many years it is a very difficult matter indeed to devise ways and means of reducing lost-time accidents still further. The Midland Electric Manufacturing Company, Limited, of Birmingham, however, have again managed to produce an accident record for last year which is an example of what can be done by sound precept coupled with constant vigilance.

Although the average number of employees increased by 15 per cent. and the man-hours worked by 25 per cent. during the year, the total number of lost-time accidents was reduced from 18 to 15. The number of hours lost declined by over 50 per cent.

When it is remembered that the M.E.M. foundry has a very high output of light castings, involving the handling of a considerable amount of molten metal during the course of a year, it is noteworthy that only six accidents occurred in this section of the works. The main works was responsible for the remaining nine accidents—a reduction of three on the previous year. The pottery achieved the distinction of a second year without a single accident.

A full-time safety officer is employed, and the company maintains a fully-equipped surgery with a trained nurse in attendance. Regular "safety bulletins" are produced bearing reference to some topical event. A "safety museum" is also exhibited in the works. Over 60 employees hold certificates, vouchers or medallions issued by the St. John Ambulance Association.

The company's aim in trying to make every one of their 1,000 employees "safety-minded" has undoubtedly borne fruit in a gratifying way.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Pre-1914 Cast Iron

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The writer was very amused with the first paragraph of your leader in the issue of February 8. After reading it one would imagine that in the bad old days, before the Great War, no one produced cast iron with a greater tensile strength than about 9 to 10 tons per sq. in.

Forty years ago the average results of 500 consecutive tensile tests, being two years' working, were taken out and gave 16.4 tons per sq. in.; no test was as low as 14 tons, and one gave 19.2 tons. The last figures are given to show the consistency of the remainder, a good number of the tests ranged from 17.5 to 18.5 tons per sq. in.

The bars were 1¼ in. diameter *cast on* the cylinders, not separate. The metal was a straight iron, without the addition of cold-blast pigs, steel, alloys or expensive refined irons. The average cost of the pig-iron in the mixture was 81s. 6d. per ton.

It is the writer's privilege to be familiar with the results obtained in many foundries all over the country producing high-duty irons, and it is only where special costly alloys are used that higher results than those given are produced, and even in those cases greater consistency is not attained.—Yours, etc.,

"AN OLD TIMER."

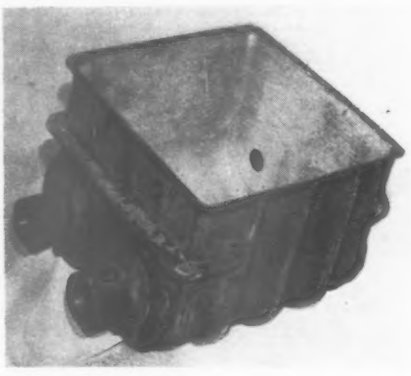
["Old Timer" masks the name of a high-grade foundryman who was many years in advance of his time, and the tests he quotes, running up to 19.2 tons per sq. in., were undoubtedly more "uncommon" than the 8 tons we cited.—EDITOR.]

Thick Tin Linings

The mixer shown in our illustration is used for blending butter, and has a cast-iron body of about 27 gallons capacity. The interior surface had formerly been tinned by the usual blowlamp and hand-tinning tools, but though the utmost skill is used such hot-tinning cannot guarantee even 0.001 in. minimum thickness of protective coating.

The butter-blender is one of four recently retinned by James H. Randall & Sons, of Paddington, in conjunction with the International Tin Research and Development Council, to which body we are indebted for permission to reproduce this article from "Tin and its Uses." For the operation use was made of the sodium stannate electro-tinning bath. Careful measurement of the coating-thickness established that at no point was there less than 0.003 in. of pure tin, while on certain surfaces known to be particularly subject to wear a coating of 0.009 in. of tin had been built up.

The lining—which is typical of modern tin-coatings deposited under controlled conditions—was non-porous, tightly adherent, and so smooth that it required no finishing other than a rapid



Courtesy J. H. Randall & Sons.

CAST-IRON BUTTER BLENDER WITH HEAVY ELECTRO-DEPOSITED TIN LINING.

scratch-brushing by hand. Such linings put an entirely new complexion on the ever-recurring problem of tinned equipment, with its relatively low first cost, as an alternative to new equipment of corrosion-resisting alloys.

The electro-deposited lining can with safety and certainty be made from ten to fifty times the thickness of a hot-dipped coating—with a corresponding increase in the useful life, but with no increase in first cost. Further, the retinning problem, which will arise at correspondingly longer intervals, is much simplified, for not only is electro-deposition rapid but in many cases the equipment need not even be dismantled. Vessels may be immersed in, or filled up with, electrolyte and in a few hours the required coating will be obtained.

Notes from the Branches

Birmingham, Coventry and West Midlands—In place of the usual annual dinner, the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen held a most enjoyable dance at the Imperial Hotel, Birmingham, on Saturday evening last.

The Institute President (Mr. W. B. Lake) was unfortunately unable to be present, but he was represented by Mr. Howard Wood (Junior Vice-President) and Mrs. Wood. The guests were received by Mr. A. Tipper (Branch-President) and Mrs. Tipper. All who were able to attend voted the evening a great success and one of the most enjoyable ever organised by the Branch.

Random Shots

Those who read the Birmingham newspapers will already have had a good chuckle over an article which appeared in one of them recently describing "a firm which was founded in 1908 to make electrical switch and fuse gear." The writer does not disclose the name of the firm, but perhaps, like the British Government that never puts its name on its pavilion at any Continental exhibition, that is not necessary! Be that as it may, the Midland Electric Manufacturing Company must have been very flattered to learn that in 1936 they "retired" to Tyseley. "Like others in Birmingham," the story goes on, "the firm is not merely a master that pays out money for so much work." No doubt, also like others in Birmingham, it sometimes feels like a master who pays out so much for so little work! The social and welfare sides of the business are described at length and one begins to wonder if any work is done at all, until, at last, the writer admits that whilst the welfare system is interesting, so is the actual work. Somehow the writer didn't seem quite so much at home here, though she (surely it must have been a she?) is very much attracted by the nice bright warmth of the molten metal as a tapping is made. One can imagine the bitter cold day outside and the pleasant anticipation of that glow, then what a shock to find that "the jet is almost too bright to gaze at." So instead of trying, she watches the worker as he "catches it in a vessel with a long handle."

* * *

The dramatic rescue of 300 British prisoners of war from the "Altmark" has thrilled everyone in this country, but the fact that the scene of the drama was Joessing Fjord is of special interest to many Englishmen, particularly in Sheffield steel circles. Joessing Fjord is the home of a well-known electric steelworks, famous for its English managers. The present manager, who has already completed about 25 years' service, is Mr. G. C. Graham, who is an ex-student of Sheffield University, and before him the position was held by Mr. Stanley Cornethwaite, a Mappin Medallist, now in South Africa.

* * *

The situation of the works itself is interesting for the only means of reaching it is by boat, a very much more pleasant journey, one imagines, than the tuppenny tram ride "dahn t'Attercliffe rooad," which is the usual approach to Sheffield's steelworks.

* * *

Imitation is the sincerest form of flattery, says an old saying, and following the lead of the members of a Chapter of the American Foundrymen's Association who took a joy trip "out West" all dressed as cowboys, the English foundrymen might visit Scotland in kilts!

* * *

The following little verse from "Link Belt News" is specially designed to make the reader creep at high temperature.

"Now I Tin Whistle"

I bought a wooden whistle, but it wooden whistle.
I bought a lead whistle, but they wooden lead me whistle.
I bought a copper whistle, but the copper wooden lead me whistle.
I bought a steel whistle, but steel the copper wooden lead me whistle.
I bought a zinc whistle, but while I zinc it wood whistle
Steel the copper wooden lead me whistle.
So I bought a tin whistle, and now I tin whistle.

"MARKSMAN."

Metals as Engineering Materials

CANTOR LECTURES DELIVERED TO THE ROYAL SOCIETY OF ARTS BY DR. C. H. DESCH

FIRST LECTURE

Historical Development of Metals

In his first lecture, Dr. Desch dealt with the historical development of metals from the earliest known examples. In the course of his survey he mentioned the Delhi pillar, and recalled an explanation, which had been obtained by the late Colonel R. E. Crompton, from the Guild of Smiths in India, as to the probable method of its construction. The explanation was that the smiths who had undertaken the work of erecting the pillar had used an immense quantity of exceedingly pure ore. On the site chosen they had made a hole in the ground, into which they had piled the ore and had kindled a charcoal fire over it. Heat was directed to the ore by means of bellows with nozzles converging on the centre of the mass. Alongside they had prepared a similar hole and had repeated the process, so that they had two masses of metal. The second mass was turned over on to the top of the first. Subsequently, they added more such masses or "pancakes" of metal, presumably applying heat to the top of the top "pancake" when the next one was added. After each addition they raised the level of the earth around it. In that way the forged pillar was built up and was finally hammered down into a true cylindrical shape. That explanation, which seemed to Dr. Desch to be fairly convincing, was overlooked by writers on iron.

Many examples of ironwork in early times and of machinery were illustrated, showing the gradual replacement of wood by iron as the processes of producing iron improved, and it was pointed out that it was the improvement of the iron industry in the 18th century which had made possible the machine age. The growth of the iron industry was being seriously checked by the exhaustion of the forests to produce charcoal, and the discovery that iron could be melted by coke made from coal had saved it.

Revolutions—Metallurgical and Mechanical

The metallurgical inventions of Darby, Huntsman and Cort in the 18th century, said Dr. Desch, had made possible the machines of Arkwright and Watt, which in turn had brought about the industrial revolution. The new steel-making processes of Bessemer and Siemens had inaugurated the age of modern machinery and of ship, bridge and building construction in steel. The introduction of alloy steels and of the light alloys had made possible the development of aircraft. In each instance a metallurgical revolution had preceded the mechanical revolution, and new and more efficient machines were developed as materials for their construction became available. In return, the stimulus given by engineering development to research in metallurgy had been very great. As an example, Dr. Desch pointed out that the efficiency of a heat engine could be increased by increasing its working temperature, and the limit to the temperature which could be used was mainly set by the properties of the materials of which the engine was constructed. The working temperatures of both steam turbines and internal-combustion engines, especially the former, had steadily risen, and each increase had been made possible only by improvements in the metals used. Research into the working properties of steels and other alloys at high temperatures was constantly in progress, and as each advance was noted, engineering design made a step forward, so that finality was never reached.

While some of the earlier inventions were the result of a chance discovery or a happy guess, such an event was very unlikely to occur at the present day. The progress of invention followed closely and was dependent on that of scientific research.

SECOND LECTURE

Metals as Engineering Components

On Monday, February 5, Dr. Desch delivered the second Cantor Lecture, pursuing the subject of Metals as Engineering Materials. In that lecture he sketched briefly the properties required of metals under modern engineering conditions.

Progress in engineering materials, he said, had been closely linked with improvements in testing methods. Quantitative testing was at first confined to the tensile test, with a transverse-loading test for cast iron, which did not lend itself well to the making of tensile-test pieces, and supplemented by such workshop tests as bending, forging and drifting for wrought iron. Fatigue testing was called for when the speed of machines was increased, while it was also found necessary to devise some test to discover brittleness which the tensile test sometimes failed to reveal.

> In a notable series of three Cantor Lectures given recently to the Royal Society of Arts, Dr. Desch has sketched the history of the early use of metals, the development of testing methods, and the position metals now occupy in the field of engineering. Below we have abstracted those portions of the lectures of major interest to foundrymen.

In engineering practice to-day, a metal part might be subjected to stress in tension, compression, shear or combinations of those. The stresses might be static or alternating, and if alternating they might be completely reversed or might have a mean stress which was not zero. The part, whether stressed or unstressed, might be exposed to chemical attack, and the effects of stress and chemical attack were not additive. Further, the stress might be applied at a high or a low temperature and might be continued for a long time, in which case both time and temperature became important factors in determining the properties. Again, under any of those conditions there might be local concentrations of stress in addition to the general stress. The problems of the strength of materials were, therefore, exceedingly complex, and the choice of suitable tests was both difficult and highly important. The most obvious plan, of subjecting a material to the exact conditions of service, and which required that the test should be continued for as long as the expected life of the part, was clearly impossible in ordinary testing for acceptance purposes or for investigation.

The hope had sometimes been expressed that a relation might be found between the mechanical properties of a metal subjected to working stresses and definite physical properties, capable of exact measurement. Such a solution of the problem was unlikely. The properties, both physical and mechanical, of single crystals were the object of exact study by a great number of methods which usefully supplemented one another, but it was not yet possible to deduce from them the properties of an aggregate of similar crystals, and even if that were done there would still be the difficulty of the heterogeneous texture of actual materials.

One set of constants, however, which could be determined physically, and was of importance for engineering purposes, was the elastic moduli. Tungsten had the highest known modulus, and the speaker also indicated that the light metal, beryllium, also had a high position. Unfortunately, however, the other properties of beryllium were such that it had not yet been found possible to take advantage of the high modulus for constructional purposes.

Modulus and Stiffness

The first fact to be noted about the modulus of elasticity was that it could not, like most of the other mechanical properties of a metal, be improved by alloying or by heat treatment. Each metal had a definite elastic modulus in the polycrystalline state, which varied only slightly with the amount of impurities present. That substantial invariability of the modulus led to a certain limitation in the use of new materials. The light metals had a low modulus. If, therefore, steel be replaced by a light alloy of equal tensile strength and advantage be taken of that to reduce the mass of a member in proportion, the modulus being only one-third as great, it might prove to be insufficiently stiff, and "whipping" and other troubles might arise. That difficulty could not be overcome by increasing the strength still further, and the design must be altered to suit the new material, or else the member must be made thicker than the calculated strength would indicate.

The stiffness of a structure could not be calculated simply from the strength of the materials of which it was made up. In a bridge the computation of the parts in tension was fairly straightforward, but in compression the conditions were different. The compression members of the Forth Bridge were tubular, and offered a very great resistance to buckling. The Quebec Bridge, also of cantilever construction, was designed with a view to economy of metal, which its engineers had considered had been used too lavishly in the earlier bridge. The compression members, therefore, were made up of plates, lightly braced together, and the disaster of August, 1907, when a lower chord collapsed and the completed part of the bridge fell, occurred although calculations had shown that the strength to resist direct compression was adequate. In such a case a small plastic yield was enough to weaken the structure.

Elastic Limit

It was usually assumed that there was a limiting stress within which the metal behaved as if perfectly elastic, whilst on exceeding it some degree of permanent (plastic) deformation was found. Great importance had been attached to the determination of that "elastic limit." The term was misleading, and it was unfortunate that it was so widely used. The more delicate the extensometer used in testing, the lower, as a rule, was the value found for the elastic limit. That was so whether the method be that of measuring the permanent set after increasing loadings and unloadings, or by the more usual plan of tracing the load-elongation curve either from readings or by an automatic recording device and determining the point at which it departed sensibly from a straight line—the "limit of proportionality." Either method involved an element of arbitrary choice, and it would be a good thing if the term "elastic limit" were to disappear. On the other hand, the device of the "proof stress" was sound and theoretically unobjectionable.

After discussing yield point, Dr. Desch went

on to deal with the tensile test, as the most important and widely used of acceptance tests of materials, and the one chiefly adopted in the investigation of new alloys or new treatments. But the data which it furnished, he said, were not physical constants. The "ultimate stress" of tensile strength was not a measure of the cohesion, except perhaps in entirely brittle materials, such as glass or white cast iron, which would break without any previous plastic deformation. For ductile materials, plastic deformation occurred during the test, and failure occurred by shear rather than by the simple pulling apart of two adjoining parts. During the last stages of the test the load had been acting on a reduced cross-sectional area, so that the maximum which appeared on the load-elongation curve was only an apparent one and did not represent a maximum stress on unit area. A curve showing the relation beween true stress and trial area of section rose steadily, being sometimes linear over a considerable range, but often rising more rapidly towards the end. He exhibited such a curve, but pointed out that it was not easy to construct, as it required a determination of the diameter at each stage of the test, as well as of the load. For that reason little work had been done on curves taken in that way, and a device for enabling them to be determined without too much trouble would be of great use. Such a curve gave important information. The slope of the linear portion, which came after plastic yielding had set in, represented the "work-hardening capacity" of the material, a factor of great technological significance. Although the experimental conditions presented some difficulty, it would seem that such a treatment of testing might deserve consideration as a means of expressing the complete mechanical properties of a material.

Process of Deformation

As to the mechanism of deformation of a crystalline mass, whilst it was known that slip and dislocation played the principal parts, the nature of the complex process was still very far from having been completely elucidated. Work on single crystals had greatly assisted, but immediately plastic deformation had proceeded a little way, the crystal was no longer single, as it would be if the process were one of simple translation, and X-ray evidence was not quite conclusive as to the respective shares of crystal fragmentation, lattice distortion and propagation and healing of flaws. In that connection he recalled the hypothesis of Beilby, attributing work-hardening, at least in part, to the production of a vitreous, non-crystalline phase in thin films on surfaces of slip, and said that although that hypothesis was very generally abandoned, it deserved reconsideration in the light of recent work on friction and polishing.

There had been differences of opinion as to the significance of the impact test on bars having an artificial notch, and it had the disadvantage that the principle of geometrical similarity did not apply to it, so that comparison could only be made between tests carried out on specimens of the same dimensions and in the same kind of machine. The resistance to impact could not be related to the static properties, although when a given steel, for example, was subjected to a series of heat-treatments, a rough parallelism might be seen between loss of ductility, and especially fall in the reduction of area at fracture, and increased brittleness as shown by the notched-bar test. It must be regarded as an empirical test, calling for care in its interpretation. Some special materials, such as the alloy cast irons now largely used for automobile crankshafts, gave low impact values, but yet were comparatively insensitive to concentrations of stress.

With regard to fatigue testing, machines for studying fatigue under conditions of combined stress had been constructed at the National Physical Laboratory, where an extensive research on the subject was in progress.

Alternating Stresses

To a far greater extent than for static stress, studies of failure under alternating stress involved a full examination of the microscopic changes which preceded and accompanied the formation of a crack. X-ray studies had given much information, and the work of Gough and Wood, in particular, had shown the close similarity between the changes under static and alternating loading, but to interpret failure exclusively in terms of the changes in X-ray patterns was to overlook the evidence from the microscope that the deformation in both conditions, and especially in fatigue, was highly localised, and that whilst one region was extensively broken down, and progressively so as the process went on, neighbouring regions underwent little distortion. In fact, it was possible to see "microscopic Luders lines" within individual crystal grains. It was in those highly distorted zones that cracks started, and it was there that recrystallisation first occurred if the deformation be interrupted and the specimen annealed. Those effects had been well studied in cupro-nickel, which had the property of etching clearly even when heavily cold-worked.

Creep Resistance

Resistance to creep was the chief factor in determining the suitability of steels for use with superheated steam. Soft metals such as lead and tin showed creep at atmospheric temperatures, whilst for steel the effect only became important from about 450 deg. C. The chief difficulty in devising tests for resistance to creep was that the metal would undergo changes of structure under the combined influence of prolonged heating and stress, so that the material which was examined at the end of the test was different from that at the beginning. Short-time tests for resistance to creep did not prove satisfactory. Such tests were necessary in industry as a means of making a preliminary selection of steels for special duty, but the results might be misleading, as the curves showing the progress of creep with time for different materials not infrequently crossed. For an aero engine, with an assumed life of, say, 100 hrs., that did not present any great inconvenience, but for steam plant it was usual to estimate for a useful life of 100,000 hrs., or ten years. It was of the utmost importance, therefore, to collect data showing the relations between time, temperature and stress over a sufficient range to allow of general conclusions being drawn. Tensile tests at atmospheric temperatures, or even at the service temperatures, were useless as indications of resistance to creep. Resistance to creep was increased by the addition of certain alloying elements, molybdenum being specially useful in that respect. A combination of several alloying elements was sometimes better than a single one. The effects on resistance to steam corrosion had also to be taken into account, especially where working was intermittent and cracking of the oxide film might occur. Differences of texture played an important part in determining resistance to creep.

Corrosion and Abrasion

In the course of a discussion of the complex factors in corrosion, Dr. Desch said it had sometimes been supposed that the quality of steel had deteriorated in recent years, on account of increased corrosion of ships having been reported. There was no foundation for such a belief. To some extent increased corrosion had been due to inferior paints, but another cause has been the shorter time allowed for the scale to become detached by rusting, whilst altered conditions of hot rolling had in some instances led to the production of a scale which was less readily detached. Where the scale could be removed by pickling or shotblasting, trouble rarely occurred if the painting be satisfactory. The improvement of the rust-resisting quality of plates was as likely to come from the control of the character of the scale as from any change in the inherent chemical properties.

An interesting fact which had emerged from researches was that abrasion was in some degree a chemical process. In a high vacuum a steel pivot could run on a hard bearing without detectable wear over long periods, and even in an Amsler testing machine, exclusion of air reduced the wear to a negligible figure. Either particles of metal were torn off and immediately oxidised, the oxide then acting as an abrasive, or, equally probable, oxygen was forced into the surface and the oxide particles were then torn out. High pressures (and as actual contact in abrasion was limited to a minute fraction of the whole surface, the local pressures were exceedingly high) had the effect of activating a chemical reaction, such as that of oxidation. It was the belief of Beilby, as the result of experiments on polishing, that actual melting of the surface layer occurred during abrasion. Direct evidence of that had been produced by Bowden and his colleagues. The temperature of melting was actually reached at local spots, and that fact played an important part in determining the amount of wear.

After dealing with alloying and age-hardening, Dr. Desch said that engineers and metallurgists were anxiously seeking for means of determining internal stresses in a casting or forging by some non-destructive method. Much had been done on the production and the more difficult interpretation of X-ray evidence for the amount and distribution of such stresses, but there was yet a long way to go before it could become a standard means of controlling engineering materials.

THIRD LECTURE

Present Position of Metals

DR. DESCH in the first place reminded his audience that iron, the most important of structural metals, was very soft and weak in the pure state, its hardness being 48 on the Brinell scale, or less than that of copper. That it could assume such different properties was due mainly to two peculiarities—its abnormal allotropic changes and its sensitiveness to the influence of carbon. Its other alloy-forming properties it shared with several other metals, but the two characteristics mentioned were exceptional.

Transformation of Austenite

After discussing some of the modifications of iron and the effects of alloying elements, the speaker said that within the last few years attention had been directed particularly to the rate of transformation of austenite into stable or metastable products during cooling, it being clear that the dynamic relations during heat treatment determined the properties of steel. That dynamic study had led to remarkably interesting results. It was known that martensite was not a stage through which a steel passed during slow cooling, but that it was formed, with finite velocity, only when a certain comparatively low temperature, in the neighbourhood of 200 deg. C., was reached. The experiment was then made of quenching a steel in the austenitic condition, not in cold water, but in a molten metal, and it was found that it would then remain soft and ductile for a long time, but that on cooling from that temperature, even without sudden quenching, it at once became hard, and then consisted of martensite of the typical kind. That experiment was the starting point, not only of new methods of

investigating the structural changes in steel, but also of important practical applications.

A steel with 1.6 per cent. carbon was heated strongly to 1,150 deg. C. and was then plunged into a bath of molten metal at 160 deg. C. At that temperature a surface could be ground and polished, the structure proving it to be unchanged austenite. On allowing the temperature to fall, keeping the specimen under observation under the microscope, the formation of martensite crystals could be watched, owing to the fact that an expansion had taken place, so that each new crystal appeared in relief. The remarkable fact was found that each crystal made its appearance fully formed within a very small fraction of a second, and did not grow further, the transformation of neighbouring parts of the austenite going on until the whole had been converted. That process was recorded kinematographically.

Rate of Austenitic Transformation

Continuing, the lecturer pointed out that the new method of investigation then consisted in heating the steel to such a temperature that it was entirely in the condition of homogeneous austenite, cooling it very rapidly to some predetermined temperature, allowing the transformation, whatever it might be, to proceed isothermally, and then to quench rapidly. Any austenite which was not transformed at the moment of quenching then became martensite, and might be identified microscopically after the experiment. In that way the rates of transformation of many steels at various temperatures had been measured. Taking a simple example, that of a carbon steel of about 0.8 per cent. carbon, it was found that there were two ranges of temperature within which the transformation was slow, and two in which it was fast. It was usual to adopt Bain's plan of plotting the logarithm of the time against the temperature, in order to give a compact diagram.

To obtain a strong and tough structure, having high fatigue resistance and good impact value, the plan adopted had usually been to quench, preferably in oil, to avoid excessive internal stresses, and then to temper to the required hardness, *i.e.*, to allow the martensite formed in quenching to revert in part or wholly to the state of finely divided ferrite-cementite mixtures. In an alternative method, the steel was cooled in a bath at a pre-determined temperature, and the transformation was allowed to continue at constant temperature. That evidently allowed of very perfect control, when the most suitable temperature of transformation had once been determined. It had found commercial application, and was sometimes called "austempering." It was confined, however, to objects so thin that the preliminary cooling through the range between 700 and 500 deg. C. was so rapid as to prevent the formation of pearlite, or one of its varieties.

Effects of Alloy Additions on Rate of Transformation

Since the conduction of heat through a metal required an appreciable time, complete hardening of a thick specimen could only occur if the conditions were such that the "critical cooling velocity," *i.e.*, the velocity needed to suppress entirely the conversion into pearlite, was low enough. That was not likely to be true for a simple carbon steel, but the critical velocity might be altered within a very wide range by alloying. Broadly speaking, nickel, chromium, manganese and silicon slowed down the transformation and, therefore, tended to make the hardening penetrate more deeply, whilst cobalt and tungsten appeared to have the opposite effect, which might be due to keeping the grain size small, a fine-grained steel transforming as a rule more readily than one with coarse grain, owing to the more favourable distribution of the nuclei. A retardation of reaction by alloying elements was accounted for by a slowing down of diffusion, which was a usual consequence of introducing foreign atoms into the lattice.

The curve showing the relation between temperature and time of transformation was not quite so simple in form for some of the alloy steels as for plain steels. There was an intermediate stage between that of pearlite and that of martensite formation. The ranges might overlap, and experiment was necessary to determine the form of the curve for each composition. When transformation occurred in the intermediate range, the crystals which were first formed were ferrite, the intervals between them being filled by fine-grained mixtures containing carbide. The mechanical properties were usually inferior to those of pearlitic steels, the tensile strength being higher, but the ductility and resistance to impact being lower. The term "Bainite" had been given to some of the typical forms, in which the ferrite had a lamellar arrangement.

The effects of alloying elements on the several ranges of transformation did not necessarily run parallel with one another. Steels containing molybdenum transformed slowly in the pearlitic range, but comparatively quickly in the intermediate range, and chromium acted on the whole in the same direction. Nickel and manganese had a retarding effect in both ranges, whilst copper and carbon affected the intermediate more than the pearlitic range.

ALLOY STEELS

Molybdenum Additions

Discussing the most widely used alloy steels, which were complex, Dr. Desch said that molybdenum was added originally to prevent the occurrence of "temper-brittleness," a form of embrittlement which was liable to occur in nickel-chromium steels if cooled slowly through the intermediate range. The addition, although small, had a great effect on the rate of transformation of the steel. The investigation of problems of that kind was being pursued by the Alloy Steels Committee of the Iron and Steel Industrial Research Council, and interesting differences had been found between the thermal behaviour of two steels, both containing approximately 0.33 per cent. of carbon, 0.8 per cent. of chromium, 3.4 per cent. of nickel and 0.5 per cent. of manganese but one of them having a further addition of 0.5 per cent. of molybdenum. Whilst both steels gave an identical arrest on heating, even on very slow cooling, the molybdenum steel retained austenite unchanged down to temperatures below 525 deg. C., and the formation of martensite was only complete at 325 deg. C. Differences of that kind greatly affected the properties of forgings made from alloy steels, and the work of the Committee was directed towards reducing those observations to order. Manufacturers, in the course of handling steels of that kind, had naturally accumulated a great mass of information as to their behaviour, and there was every prospect that the relations between the effects of the several alloying elements, complicated as they might seem, would before long be expressible in simple terms.

Commenting on some of the truly remarkable results of adding small quantities of alloying elements to carbon steels, Dr. Desch said that probably the highest mechanical properties yet reached were given by a steel of the nickel-chromium-molybdenum vanadium class which in the hardened and tempered condition gave the remarkable figures of 149 to 153 tons per sq. in. tensile strength, 9 to 10 per cent. elongation, 8 to 12 ft.-lbs. Izod value, and a fatigue range by the Wöhler test of ± 57 tons per sq. in. on plain bars, and ± 28.5 tons on notched specimens. Such a steel was suited for connecting rods.

Nickel-Chromium Steels

With a sufficient addition of a metal which extended the gamma range, such as nickel, one arrived at a steel which retained the austenitic structure, however slowly cooled. If any transformation occurred it was at a very low temperature, so that quenching in liquid air might be necessary to produce the alpha phase. That phase, however, was also produced when the alloy was cold-worked, so that it then became magnetic. The most important of the austenitic steels were those containing both nickel and chromium, including the very important 18:8 alloy. The carbon content was kept as low as possible. Small additions of other elements, especially titanium, tungsten, molybdenum or niobium, were made when the material was to be welded, as otherwise a change occurred at the grain boundaries when the steel was held for any length of time at a temperature near to 500 deg., such that brittleness and liability to chemical attack were set up near the weld. The function of the added elements was to combine with the carbon, so preventing the chromium from seizing it.

Surface Hardening

One of the most recent methods for hardening the surface without altering the toughness of the core to improve the properties of a steel, continued the speaker, was to apply cold working to the surface by rolling, hammering with a rounded hammer or swaging hammers, or by the "cloudburst" method of showers of impinging steel balls. In that way a superficial layer of cold-worked material was formed and, perhaps more important, ultramicroscopic cracks were closed up. In a reference to the older method of case-hardening, he said that steels with 5 or even 7 per cent. of nickel were suitable, and for gears intended for high duty a steel with 0.3 per cent. carbon, 4 per cent. nickel and 1.5 per cent. chromium gave good results. That steel did not require quenching, air-hardening being enough.

Powder Metallurgy

After a brief reference to nitriding, Dr. Desch mentioned the development of "powder metallurgy" or "metal ceramics," which gave possibilities of making certain engineering parts with quite novel properties. The metals were used in the form of powder and compacted by pressure followed by heating. The method had long been used for metals of very high melting point, such as platinum and tungsten. It was quite possible to melt even tungsten in an arc or high-frequency induction furnace; the difficulty was that there was no material which would serve for crucibles except carbon, which was out of the question on account of chemical reactions. For metals of lower melting point the powder method might be used to give objects of accurate dimensions, as a substitute for die-castings, but it was also valuable for making masses with any desired porosity. Porous bronze bearings, made by compressing copper, tin and graphite powders together and heating until sintered, were useful on account of their power to hold oil. It was possible to make a bearing of graduated composition, in order to combine two qualities, that of giving good adhesion to the supporting steel at the back, while having a harder wearing surface. There were many possibilities in that direction. Powder metallurgy was also used for the production of the hard carbide masses used for cutting tools and dies, consisting of particles of tungsten, titanium and other carbides, united by sintering with more fusible metals, mainly cobalt. For the balancing of flywheels, masses of a very heavy sintered material, originally devised for radium containers, and made up of tungsten powder sintered with copper and nickel, had found an unexpected application.

Permanent-Mould Grey-Iron Castings

In our issue of February 8 we reproduced an article by Edward C. Hoenicke, which outlined the present position of the Eaton Erb process of making grey-iron castings in permanent moulds. The production last year, it will be recalled, attained no less than 28,200,000 castings. Through the courtesy of Mr. R. Baring-Gould, of 70, Victoria Street, London, S.W.1, who is handling the process in this country, we are now able to reproduce illustrations of some typical castings made by the process. From these examples it will be clear that reasonable complexity of design is not prejudicial to production by the permanent-mould process.

The composition of the cast iron used in the making of these castings is standardised at T.C, 3.40 to 3.60; Si, 2.40 to 2.60; Mn, 0.6 to 0.8; S, 0.10 (max.); and P, 0.30 (max.) per cent. The iron has a tensile strength of 13.3 to 17.4 tons per sq. in., associated with a Brinell hardness of 170 to 207.

FIG. 1.—HIGH-PRESSURE OIL PLUG VALVE WHICH HAS TO WITHSTAND A PRESSURE OF 2,000 LBS. PER SQ. IN.

FIG. 2.—WASHING MACHINE GEAR AFTER MACHINING.

FIG. 3.—MOTOR OIL PUMP BODY; 500,000 ARE NOW IN SERVICE.

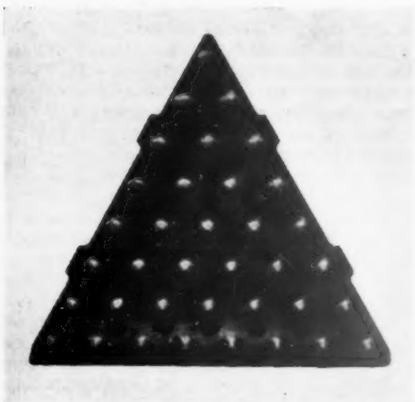


FIG. 4.—PAVING BLOCKS REQUIRED TO WITHSTAND SHOCKS.

FIG. 5.—BEARING CASTING FOR THE MOTOR TRADE.

FIG. 6.—REFRIGERATOR PUMP HEAD. NOTE VARYING SECTION THICKNESSES.

FIG. 7.—CONNECTING ROD.

FIG. 8.—CRANKSHAFT.

FIG. 9.—CYLINDER BLOCK CASTING.

Publication Received

Methods for the Detection of Toxic Gases in Industry. Leaflet No. 7. Carbon Monoxide. Published by H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 1s. 6d. net.

Among the industrial situations in which carbon monoxide may be encountered in dangerous concentrations are blast furnaces and foundries. The gas is colourless and odourless, and is, therefore, most insidious in its action. The first symptoms of poisoning are shortness of breath and palpitation on exertion, accompanied by headache, which increases in severity. With increasing intoxication the judgment becomes disturbed, and the affected person may not realise his danger. An atmosphere in which a concentration as low as 1 part in 2,000 is present may prove fatal in about one hour to a person engaged in an active occupation. On the other hand, concentrations below 1 in 10,000 may be regarded as relatively harmless for all practical purposes.

The standard method developed for the detection of carbon monoxide in industry consists in drawing samples of the atmosphere under test through a known area of test paper, treated with palladium chloride, at a slow and constant rate, by means of a 5-litre aspirator. This method enables interfering gases to be removed by allowing the sample first to pass through a tube of activated charcoal. Sampling is continued until a stain is obtained on the test paper which compares with the standard colour chart; the concentration present is then determined by comparing the time required to reach the necessary colour, with the times given on the chart. In this way concentrations of 1 part in 500 can be detected in less than two mins., and of 1 part in 10,000 in half-an-hour. Full instructions for carrying out the test, and the colour chart, are contained in the leaflet, which has been issued by the Department of Scientific and Industrial Research.

Cleaning Aluminium-Alloy Castings

METHODS AND EQUIPMENT RECOMMENDED

One of the important economies to be secured from the use of aluminium-alloy castings is the ease with which they can be fettled. Apart from the lightness, which facilitates handling during the finishing operation, castings of these alloys possess certain natural characteristics which constitute further advantages. Relative smoothness of their cast surfaces, absence of burned-in sand, the non-abrasive character of the metal, and relative ease and speed with which the metal can be trimmed and ground, all make for economy in the fettling shops.

Core knock-out, chipping, sawing, grinding and polishing are normally executed with the standard tools developed for these purposes, although certain modifications in the tool operation may be required to gain the best results with aluminium. Proper selection of tools and materials depends to some extent on the size and shape of castings to be finished, and on the nature of the finish required. Therefore, the following recommendations, while based on general practices, may require modification in certain cases to provide the most efficient finishing system for particular plant conditions and casting design.

Removal of Cores and Runners

Normally the removal of cores from aluminium-alloy castings presents few problems other than exercising sufficient care to prevent breakage of castings, particularly while they are hot. A light tapping of the casting and possibly some probing with a bar generally is sufficient to loosen the sand so it will run out of the casting cavities readily. Pneumatic rapping machines for small castings and air hammers for large castings will facilitate this removal.

Gates and risers that are readily accessible are best removed with band saws. For average work, heavy-duty woodworking saws have been found satisfactory, but for heavy work high-speed metal-working saws are preferred. Such saws are operated at speeds of 3,000 to 5,000 ft. per min., the speed depending upon metal section; the heavier the section the slower the blade speed. The width and gauge of the saw blade, as well as the tooth pitch, also are controlled by the thickness of section to be cut. Blades up to 1½ in. in width by 16 gauge, with 3 teeth per inch, are common for extremely heavy work. For light work, blades ½ in. wide by 20 gauge and with up to 8 teeth per inch are used satisfactorily.

Ordinary carbon steel in the spring tempered condition is largely used for these saws and can be resharpened readily by filing. Such saws should be provided with not more than a 5-deg. top rake and about 0.030-in. clearance to minimise heating due to the teeth dragging. A saw with too much top rake or hook will feed into the work too rapidly for hand feeding, and may result in the blade pulling out of the guides. Saws such as used for cutting wood, which provide teeth with a negative rake, should not be used with aluminium. A cutting oil, stick grease or tallow should be used as a coolant and lubricant, particularly for heavy cutting.

Pneumatic Chippers

Git cutters also provide a means of removing gates from accessible locations, although often not as cleanly as a saw. Care must be taken in keeping such cutters sharp, or the metal may tear below the casting surface.

Pneumatic chipping hammers may be used to remove gates and risers that cannot be readily sawed or sheared off. To avoid breakage of metal into the casting proper, the preliminary cut with such chisels should be made a little above the surface. Excess metal then can be removed by subsequent operations. Pneumatic chipping hammers are likewise useful in removing fins and surface irregularities as well as the final traces of gates which were cut off by a saw or git cutter. By substituting a blunt-nosed tool in place of the chisel, an excellent tool is provided for peening other surface irregularities. A cutting or lubricating oil will be found useful with chisels.

Grinding Operations

The great variety of grinding wheels available for both portable and stationary tools permits considerable flexibility in snagging and grinding operations. For small castings, bonded abrasive wheels of suitable diameters, mounted on conventional lathes, are generally satisfactory for rough grinding on external surfaces. Flexible-shaft machines with small burrs or abrasive wheels readily reach the other surfaces.

For large castings pneumatic or electrically-driven tools are useful for rough grinding. When considerable metal is to be removed, particularly from a flat surface, rotary vertical grinders equipped with bonded abrasive cup wheels are most satisfactory. Flexible abrasive paper discs used with such portable vertical grinders are better adapted to irregular surfaces. In other cases, wheels built up of muslin or canvas to the required thickness, and set up with abrasives glued to their circumference, are employed with portable grinders for rough grinding on irregular surfaces.

The type and size of abrasive, type of bond, and wheel speed are important considerations in the selection of polishing equipment. Aluminous abrasives from No. 20 to No. 80 are generally preferred for the rough-grinding work, their characteristics providing the desired cutting efficiency. The use of solid bonded wheels with suitable synthetic-resin bond and filler is also a preferred practice, although various vitrified bonds are used for some applications. Selection of the proper bond is important to provide wheels with the least tendency to load with metal. Muslin or canvas wheels to which the abrasive is attached with glue must be set up with special attention to both composition of glue and methods of application. Manufacturers of both wheels and abrasives are familiar with requirements for aluminium sand castings and are usually in a position to recommend the wheels best suited for any particular operation.

Since aluminium alloys are somewhat softer than many of the other metals, softer abrasives and bonding materials are required. Wheel speeds must therefore be reduced to maintain cutting efficiency and to prevent overheating. For most rough polishing, wheel speeds of 5,000 to 8,500 surface ft. per min. are adequate in the case of cup wheels and abrasive discs on portable grinders; a grinder speed of 4,000 to 5,000 r.p.m. is sufficient. Lubricants such as stick tallow or grease may be used when necessary. These should be used with care to avoid excessive lubricants being driven into the pores of the casting and spotting the surface by seepage during some later finishing operations.

Filing and Shot-Blasting

Files find considerable use for final touching up of castings and for cleaning sections that cannot be ground with larger tools. A single deep-cut, coarse, curved tooth file will remove metal rapidly without loading of the teeth. Similar files with notched teeth, which break up the cuttings, are even more rapid, but do not produce as smooth a surface. A tooth pitch of 9 to 12 teeth per inch generally is preferred for these files. For smaller work and finish-filing, long-angle lathe files or hand cut files may be used satisfactorily. Files of this type should be provided with 14 to 20 teeth per inch cut with a side rake of 45 to 55 degrees.

Shot-blasting offers an excellent method for cleaning aluminum-alloy sand castings as well as providing a uniform pleasing appearance to the finished part. Surface discolouration, minor surface roughness, and roughness from coarse grinding operations can be removed readily or masked by shot-blasting. Unsoundness which may be present just below the surface is generally revealed by blasting, which makes this procedure desirable in connection with the final inspection of castings.

Any of the standard blasting equipment will be found suitable for aluminium castings, providing the conditions of operation are chosen to prevent excessive warping. With a suction type of blast this is not as important a consideration as with a direct pressure blast. For small light work using direct pressure equipment, ¼ to ⅜ in. nozzles and about 60 lbs. per sq. in. air pressure are generally satisfactory. Nozzles up to ½ in. diameter and pressures up to 90 lbs. per sq. in. with similar equipment should take care of the heaviest castings. Suction-type equipment using 90 lbs. per sq. in. seldom will result in warping. Of course, from the standpoint of cost, it is always desirable to select nozzles and pressure conditions which will provide the desired finish with a minimum consumption of air and abrasive.

There are a number of materials suitable for blast use. Where sand is used, a washed silica sand of 40 to 50 mesh is suitable for general purposes. Coarser material, such as crushed silica rock up to 6 mesh, may be desired for certain ornamental finishes, but is generally too rough for normal cleaning. Finer material down to 200 mesh also may be desired in some cases for ornamental work, although this is not a desirable practice for average work. Chilled shot may be substituted for sand if desired, such substitution being required by certain casting users to eliminate the hazard of sand remaining in a casting and later working out into the assembly of which the casting becomes a part. The proper grade of chilled shot for any particular job can be selected from the various sizes.

Upsetting Warped Castings

Castings often may become warped during knocking-out or by the natural internal stresses set up during solidification and cooling. With suitable care even the least ductile of the aluminium-alloy castings can be straightened within limits. In many cases, this operation can be done cold. In a few cases, particularly when the less ductile alloys are concerned and where considerable deformation is required, local heating may be required.

British Standard Voltages

Since the publication in 1932 of the third edition of this British Standard, the development in a.c. transmission and distribution has brought about considerable changes in practice, and the revised edition of B.S. 77, recently issued, takes account of this progress. The chief change between the old and revised specification is the substitution of two standard voltages—"system voltage" and "declared voltage" for the four voltages included in the 1932 edition. A revised list of standard voltages is given. Copies of this British Standard can be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1. (Price 1s. 2d., post free.)

Foundry Lay-out and Buildings*

By F. J. COOK, M.I.Mech.E. (Past-President, Institute of British Foundrymen)

It is not so very long since a very prominent American foundryman visiting this country stated that an opinion existed among some American foundrymen who had not been over here that the British foundries were generally so dark that it required a light to find one's way about, and so low that one had to be careful not to strike his head against the roof principle. Whilst this is, of course, an exaggeration, it does at once conjure up memories of many buildings which have to serve as foundries. The view, however, that any ramshackle type of building is good enough for a foundry has generally disappeared. Old-type buildings are now being replaced by modern well-designed shops in which transportation, light, ventilation, ample space and lighting facilities are receiving special attention, all of which tend to economical and well-ordered working and consequently lowering of production costs.

In connection with a lay-out, every plant presents special problems of a geographical nature and therefore no hard and fast rules can be given. There are, of course, many advantages to be obtained from easy access to railways and canals for delivery of raw materials adjacent to the position in which they have to be used, and if the foundry has to work in conjunction with an engineering works, it is desirable to place it at the end of the machine shops with a stock yard or stores in between, thus enabling ready distribution of castings to the various groups of machines. It is also desirable that the pattern-shop and pattern stores should be in close proximity to the foundry, and the patternshop near to the drawing office, thus ensuring that there shall be close contact between these essentially complementary departments.

Foundry Buildings

The type of building which is receiving a great deal of favour consists of a steel-frame building with dwarf curtain walls 7 ft. or more above floor level, followed by good height of glazing on the north, east and west sides, and a good width of glazing on each side of an Apex roof. The remainder of the building is closed in with asbestos sheeting with Trafford type tile adopted for the roofs, and wide gutters with ample facilities for cleaning which is also a necessity.

Asbestos sheeting is used in the case of foundries instead of galvanised corrugated sheets, owing to the very short life of steel sheets. Asbestos sheeting is, however, of a brittle nature and in some instances this type of sheeting is replaced with steel sheets covered with bitumen. Bitumen, however, is black and a bad reflector of light. To give better lighting within the building, the inside surface can be covered with aluminium or white paint, thus overcoming this difficulty. Ample ventilation is provided with continuous louvres for main high bays and round ones for low narrow bays.

Steel-frame buildings with asbestos sheeting generally give a saving in first cost. Brick buildings with slated roofs generally cost, according to size and locality, from 10 to 12 per cent. more than the steel-frame type. If bitumen-covered sheeting is adopted, the cost is about mid-way between the two. The steel-frame type of building allows better facilities for a continuous row of lighting zones along sides and ends. With brickwork, the space available for windows is restricted.

Floor Requirements

The first point to be considered in connection with the design of a new plant is the floor area required to give a definite output, and here the designer meets with the greatest obstacle, for there are no reliable rules to go upon. Some time ago an American tried to get out a comparison for floor areas of foundries in America and abroad, grouping them into their various classes, and, for the group under consideration, the floor area varied from 405 to 1,100 sq. ft. of floor area per ton of daily output of castings. This figure, of course, is in a measure governed by the different sizes and weights of the castings being made and the daily outputs. However, the writer has had an experience of two foundries in this country both producing the same class of work and with very similar weekly tonnage outputs. In the one case the foundry has a floor area of 12,150 sq. ft. and the other 57,000 sq. ft., or nearly 4¾ times greater. Core stoves and cupolas were in nearly similar proportion and both foundries considered that they were working to capacity. The floor area per square ft. per ton of castings in the two cases was 600 and 2,800. The American author previously referred to states that German foundries doing similar work are generally about three times the size of the American.

It is necessary, in arriving at a decision as to floor area to be provided, for the designer to take into consideration the amount of work being turned out under the old conditions and visualise as far as possible the advantages that can be obtained with an improved lay-out.

General Dimensions

In selecting a suitable site, ample provision should be allowed for extensions, particularly in the length, for it is surprising in how many instances this information has subsequently proved beneficial.

Width.—Concerning width, the designer has a better guide, for experience has shown that for the type of foundry under consideration, a width of 30 ft. is on the narrow side, and it is only in very exceptional circumstances that a greater width than 50 ft. is of advantage. The general sizes for medium and large work range from 45 to 55 ft.

Height.—For the general run of jobbing work, a very good plan as to height is obtained by making the distance from the floor level to crane gantry half the span and with a height of 7 ft. 10 in. above the gantry to the underside of roof truss; this latter dimension will, of course, depend very much upon the size of the cranes to be employed. Naturally, there will be exceptions, particularly in foundries making very long castings made vertically in pits.

Pitch of Roof.—It is essential that as much light as possible shall be directed on to the floor of a foundry, and it is therefore desirable that the pitch of the roof shall be as flat as possible and should not exceed one-quarter of the span. Even a little flatter than this is an advantage for a good distribution of light.

Ample provision in any foundry for lifting and transportation is of supreme importance, particularly over the moulding floor. This is a point that rarely receives the attention due to it. It is a great waste of time and money for moulders to be idling about waiting for the crane and for the foreman to need to have most of the moulds ready before the cupola can be started up. The latter is often a cause of excessive overtime, and it also frequently happens that a great deal of moulding ceases as soon as pouring begins.

A rule that has worked very well in jobbing foundries is to provide an overhead electric travelling crane for every 100 to 150 ft. run floor space with a minimum of two cranes in any bay. One of the cranes should be of a capacity of twice the weight of the largest casting it is intended to make provision for. In connection with the latter point, if this calls for a crane of more than 50 tons capacity, with only an occasional lift, it can be met by having the combined capacity of two adjacent cranes equal to the full load required, and using them in connection with a lifting beam.

Recent Examples

The drawings of three recently designed new foundries were given. One was a very large one having main moulding bays 50 ft. wide. The height of the crane gantry is 20 ft. 6 in. and above the gantry 9 ft. 6 in. The second was for medium outputs with moulding bays of 50 ft. and 40 ft., the latter being for small work. The height of the gantry in the large bay was 7 ft. 6 in. above gantry rails to roof truss. In each of these cases the cupola and stock yard are inside the main building, with overhead travellers delivering material from railway trucks directly on to the cupola stage. This arrangement has met with general favour, as it greatly facilitates the easy charging of the cupolas and storage of raw materials.

The third design shown was for a medium output, but where fairly large box parts are involved. This has a width in the main bay of 55 ft., with 26 ft. up to the crane gantry and 7 ft. above. There is also a side bay, 30 ft. wide and 16 ft. to the crane gantry, for small work. The cupolas in this case are stored in a house open to the foundry, and the cupola stage is fed by an overhead crane with magnet.

The lecture was also illustrated with a number of interesting lantern slides showing salient points of modern design.

* Abstract of a lecture given before the London Branch of the Institute of British Foundrymen, Mr. Barrington Hooper, C.B.E., presiding.

A.R.P. Respirator Telephones

The possibility that in wartime it might be necessary for persons employed as telephone switchboard operators, or in other positions where regular use of the telephone is entailed, to continue working at their posts in circumstances where they are exposed to poison gases, led to the development of a special form of repirator called a respirator telephone. This instrument consists of a standard civilian duty respirator fitted with a special microphone for use with a telephone headgear receiver. Provision is made for connecting the instrument to a telephone circuit by means of a plug and socket. For certain members of public air raid precautions services respirator telephones will be provided free by the Government. If other persons require the use of respirator telephones it should be noted that these instruments are not supplied to subscribers by the Post Office, but the Post Office has granted permission to the under-mentioned firms to sell to subscribers respirators of this type:—Airguard, Limited, Holborn Viaduct House, Holborn Viaduct, London, E.C.1; Siebe Gorman & Company, Limited, 187, Westminster Bridge Road, London, S.E.1; Phoenix Telephone & Electric Works, Limited, Edgware Road, London, N.W.9.

The permission has been given subject to conditions which ensure that the telephone apparatus will conform to Post Office specifications and design and that the respirator will be of an approved Government type; but the Post Office itself will accept no responsibility for its efficiency in regard to protection against gas or for the electrical efficiency of the apparatus.

The foregoing particulars are taken from A.R.P. Department Circular No. 320/1939, entitled "Civilian Duty Respirators fitted with Microphone Attachments." The Circular may be obtained from H.M. Stationery Office, York House, Aldwych, London, W.C.2. (Price 1d.)

Cast Iron for Modern Engineering Applications*

By T. TYRIE

Production of High-Duty Cast Iron

At the outset it may be claimed that the production of high-duty cast iron involves close control of raw materials, the use of refined pig-iron or steel scrap in the cupola charge, a wide range of alloy additions, special melting and foundry techniques, and in extreme cases the application of heat-treatment, all of which make unlimited demands upon the resources of the foundry executive and metallurgist. If the strength of common cast iron be taken as that of Grade C metal in B.S.I. Specification 321/1938, that is, 9 tons per sq. in. on a 1.2-in. dia. bar, and ordinary cast iron at Grade A requirements of 11 tons per sq. in., these two cover much of the production in normal engineering castings, and in structure follow largely the types shown in Figs. 1 and 2.

Special irons having higher strengths up to Grade 1 of the B.S.I. Specification 786/1938, which demands 14 tons per sq. in. on a 1.2-in. dia. bar, may be likened to the cylinder irons so frequently quoted as the first improvement in quality, and may be made from the ordinary raw materials of the foundry by the exercise of proper care in the selection of pig-iron and scrap. The object to be achieved is the avoidance of the duplex structure of pearlite and ferrite and the substitution of an all-pearlitic matrix, which is accomplished by attention to composition in relation to casting section and cooling rate.

For irons of Grade 2 quality in the latter specification, giving a minimum of 17 tons per sq. in. tensile on the 1.2-in. dia. bar, the need is most simply met by reduction in the total carbon content, that is, the production of a definitely hypo-eutectic iron, which reduces the size and quantity of the flake graphite, together with a reduction in the phosphorus content. This object may be carried out conveniently by the use of a refined pig-iron or selected steel scrap, the ultimate structure being of all-pearlitic nature with small flake graphite in reduced quantity as illustrated in Fig. 3.

This might well be regarded as the point of departure for modern high-duty cast irons, which may be defined roughly as irons having a tensile strength of over 18 tons per sq. in., this strength being the maximum which can ordinarily be reached in founding cast iron by exercising the greatest possible care and using the best technique, but without employing special processes or alloy additions. With proper metallurgical control, the use of steel scrap in producing these low-carbon irons can be carried to much greater lengths than is usual in the ordinary foundry, and irons having 20 to 22 tons per sq. in. tensile may be prepared. Such strengths are associated with low total carbon content down to 2.2 per cent., the silicon being raised to 2.5 per cent. or above to maintain a grey and machinable product.

Such irons, however, have a short life in the ladle, are sensitive to minor variations in melting technique and foundry practice, and give rise to shrinkage difficulties which can only be overcome by the provision of runners and risers of the self-feeding type, and for these reasons it is more common in commercial practice to maintain the total carbon at 2.6 to 2.8 per cent., with silicon of 2.0 to 2.5 per cent., according to section, resulting in slightly lower strength, but sounder castings. Structurally, such metal is all-pearlitic, broken only by very fine flake graphite and small amounts of phosphide, as shown in Fig. 4.

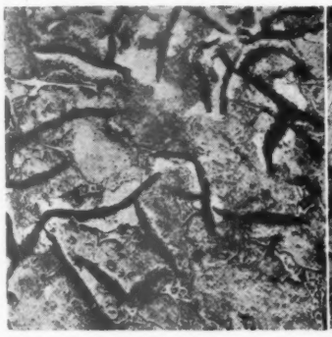


FIG. 1.—COMMON CAST IRON.

FIG. 2.—MEDIUM-STRENGTH IRON.

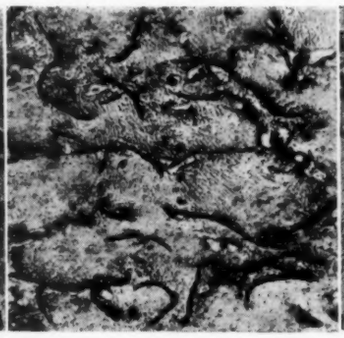


FIG. 3.—HIGH-STRENGTH CAST IRON.

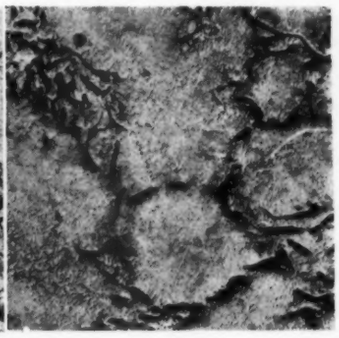


FIG. 4.—HOT-MOULD IRON.

(Photomicrographs at 200 magnifications.)

Hot-Mould Iron

Of special processes for the production of high-duty cast iron, the Lanz-Perlit hot-mould process is now fairly well understood, but is of limited application in that it is difficult to deal with castings of widely varying section, it is at times difficult to arrange for moulds to be properly heated and ready at the same time as the metal, and finally the slow cooling tends to give coarse graphite and erratic results in mechanical test. In essence, the hot-mould process for making iron castings consists of pouring metal of medium carbon and low silicon content into a mould preheated to between 200 and 400 deg. C., depending upon the thickness of the casting; the preheated mould delays the rate of cooling, and by careful adjustment of composition, mould temperature and metal section, producing an all-pearlitic structure in varying sections from metal which normally would yield a white or mottled structure. Such metal is not characterised by exceptionally high tensile strength, 15 to 18 tons per sq. in. being general, but gives sound tough castings and is used in applications where low silicon content is advantageous.

Inoculated Iron

Metallurgical investigations have confirmed certain deductions from practical experience that the superheating of cast iron above ordinary melting temperatures refined the graphite, and if the superheating was sufficiently high and the time sufficiently long, the iron ultimately solidified white. Such iron, by the addition of suitable graphitisers such as silicon, calcium silicide or ferro-silicon in powder form, can be restored to the grey condition, and it was found that the effect of such materials when added to the molten metal was quite out of proportion to the amount added, from which fact sprung the terms inoculating agent and inoculation, and the nuclei theory advanced to explain the properties of the inoculated irons so produced.

Subsequent experience and investigation have shown that the nuclei theory does not explain satisfactorily the *modus operandi* of the process, and a better explanation would be welcome. It thus becomes possible, however, to take a relatively common iron which would normally show a coarse fracture after remelting and to refine the graphite by super-heating or by steel additions, and by subsequent inoculation to make it solidify finally with fine flake graphite.

This method yields the highest tensile strengths available to-day from grey irons tested in the as-cast state. It has the further advantage of producing castings very uniform in properties over varying sections, and may be used for all types of engineering castings where high stresses have to be met, where reduced sections are desired, and, where the ductility of cast steel is not essential, yields an excellent substitute. It consists essentially of the addition of a graphitising material to an iron which in the section required would normally be white or mottled. Two processes are in regular use in this country. "Meehanite" is the name given to one such iron originally patented in the U.S.A., the British patent being No. 210,118. This iron is one in which a low-carbon low-silicon material composed largely of steel scrap is made grey at the cupola spout by an addition of calcium silicide, which is added to the metal stream by means of a small hopper controlled by a small electric motor and adjusted to deliver the powdered silicide at a predetermined rate somewhere in the region of 120 ozs. of calcium silicide per ton of metal. Several grades of Meehanite (depending upon the constitution of the charge) may be produced, and strengths of 20 to 25 tons per sq. in. are regularly obtained from unalloyed material in the as-cast state. Still higher strengths are obtained by heat-treatment or by alloy additions.

Another method is to inoculate with a mixture of nickel and silicon or ferro-silicon under the Patent (No. 290,267) held by the Mond Nickel Company, Limited, the metal so produced being called "Ni-Tensyl." The iron is melted with less silicon than would be needed in the final casting, and the balance of the silicon, together with an amount of nickel approximately equal in quantity, is added at the spout, generally as

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* Extracted from a Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. Norman E. Erskine presiding.

ferro-silicon of at least 70 per cent. silicon content. By this means strengths of 20 to 26 tons per sq. in. are obtained, and, as with Meehanite, may be enhanced by suitable heat-treatment or further alloy additions.

Structurally, inoculated irons are fully pearlitic, with relatively fine graphite. Although the manufacture of inoculated irons has proved to be commercially possible, it cannot be undertaken lightly. Foundry technique with respect to shrinkage, runners and risers, sands, etc., requires revision, and it may be necessary greatly to improve cupola practice. It is a process which will continue to be used, and its use will doubtless be extended. The following points may with advantage be borne in mind:—

(1) There is seldom any point in inoculating an iron which by its composition in relation to section would solidify grey without the aid of an inoculant, since it is possible that the inoculant might graphitise the pearlite and produce ferrite, its presence being harmful rather than beneficial to the metal.

(2) Similarly, it is useless to attempt to inoculate an iron which is appreciably over the borderline of white iron, since an iron which is very white cannot be made grey by inoculation.

(3) The regular production of high-duty iron demands close metallurgical control and a knowledge both of what goes into and what comes out of the furnace. It also demands a much improved technique in melting, running and gating, feeding, etc., and in adapting designs to suit the metal.

(4) Inoculation is not a means whereby a common iron mixture can be made into good iron. It does not necessarily reduce the number of mixtures dictated by the variety of sections to be dealt with, but does introduce a measure of accommodation in this respect not experienced with straight cupola mixtures.

Alloy Cast Irons

The addition of alloys to cast iron is practised for four main reasons:—(1) To improve the quality of ordinary engineering cast iron without appreciably altering its character. (2) To overcome practical foundry difficulties which limit the extent to which carbon and silicon may be reduced in the search for high-duty irons. (3) To produce special materials such as the austenitic and martensitic cast irons, which differ appreciably from normal cast iron. (4) To produce cast irons suitable for heat-treatment. The effects produced by alloy additions reveal themselves in differences in structure or the properties of the alloys, and as much has been written on this subject during the past few years, it will suffice to summarise the effects of such alloy additions.

In a series of simple iron-carbon alloys, the one with the lowest melting temperature at about 1,150 deg. C. contains 4.3 per cent. carbon, and is known as the eutectic. The introduction of silicon and phosphorus lowers the amount of carbon in the eutectic, and some of the alloy additions produce similar results, whilst others have the opposite effect of increasing the amount of carbon in the eutectic. Those alloys, like silicon, which lower the carbon in the eutectic generally reduce the chilling tendency of the iron, whilst those which raise the carbon in the eutectic tend to make the iron chill more readily.

The broad effects of the common alloy additions are tabulated in Table I. Nickel, copper, aluminium and silicon in moderate quantities enter completely into solid solution in the iron, that is to say, they dissolve completely in the metal and remain dissolved in the solidified metal, showing no separate constituent under the microscope. In this condition, they tend to break down the cementite or iron carbide, graphitising the iron and reducing its chilling properties. Chromium, manganese and molybdenum, on the other hand, enter only partially into solid solution in the iron; the rest of the metal added forms carbide, which is usually present in the form of complex carbides with the carbide of iron.

TABLE I.—*Effect of Common Alloys on Some Properties of Cast Iron.*

	Carbon content of eutectoid (pearlite).	Temperature of critical point (pearlite point).	Carbon content of eutectic.	Chill.
Manganese	Lowered	Lowered	Raised	Increased
Chromium	Lowered	Raised	Raised	Increased
Molybdenum	Lowered	Raised	Unchanged	Increased
Nickel	Lowered	Lowered	Lowered	Decreased
Copper	Raised	Unchanged	Lowered	Decreased
Aluminium	Lowered	Unchanged	Lowered	Decreased
Silicon	Slightly lowered	Raised	Lowered	Decreased

These complex carbides are more stable than the original cementite, and so the tendency of the metal to chill is increased by the presence of these alloying elements. The precise result of the stabilising action on the carbide and its effect on chill cannot be given exact numerical values by reason of the fact that it varies somewhat with the quantity of alloy added and the composition of the metal to which the addition is made, but the relative effects of the alloys on chill may be expressed in relation to silicon as unity, as shown in Table II, where the negative sign indicates that the element does not graphitise as silicon does, but increases chill. It will be seen from these figures that to substitute nickel for silicon without affecting the chill, one should reduce the silicon by one-third to two-fifths the amount of nickel added. Similarly, to add nickel and chromium to cast iron without influencing chill, the addition should be in the proportion of one part of chromium to three parts of nickel.

TABLE II.—*Relative Effects of Common Alloys on Chill, Numerically Assessed.*

Element.	Graphitising value.
Silicon	1.0
Aluminium	0.5
Copper	0.35
Nickel	0.3 -0.4
Manganese	-0.25
Molybdenum	-0.35
Chromium	-1.2

It is a general metallurgical dictum that a solid solution is harder than a pure metal; thus, alloys dissolved in the matrix of the iron will raise its hardness. In addition, the hardness may also increase owing to the formation of harder constituents such as martensite, by suppression of the pearlite change, and owing to an increase in the combined carbon which will be brought about if the carbide stabilising elements, molybdenum, chromium or manganese, are used. The influence of alloys on the hardness of cast iron is therefore the sum of two separate effects, the effect on the matrix and the carbide stabilising influence. Whilst in general these effects must be considered together, in consideration of hardness as it affects machinability, a distinction arises. An increase in hardness caused by an increase in the carbide content will lead to increased difficulty in machining, but one which is due to an alloy dissolved in the matrix gives very little extra difficulty unless the alloy is present in sufficient quantity to form martensite.

The difficulty in machining arising from increased carbide in the structure may be overcome to a certain extent by the addition of a graphitising element which will tend to break up the carbides; hence the general principle of combining chromium and nickel. Throughout, the desirability of the all-pearlitic structure has been stressed, and it is interesting to trace the effect of alloy additions on this. The eutectoid or pearlite in a pure iron-carbon alloy contains 0.9 per cent. carbon in the combined condition, but in ordinary cast irons, owing to the presence of other elements, this content is somewhat below 0.9 per cent. If more combined carbon be present than is required to form pearlite, the balance exists as cementite, a material which should never be present in more than small quantities in strong irons since its brittleness reduces the strength. If less than the amount of combined carbon required to form pearlite be present, the structure will not be all-pearlitic but will contain ferrite which is a relatively soft material and not nearly so strong as pearlite. It will be seen from Table I that all the alloys given, except copper, lower the amount of carbon in the pearlite and hence the desired pearlitic structure is obtained with a lower combined carbon content.

(To be continued.)

Employers' Obligations under Calling-up Provisions

With many more age groups likely to be called up in 1940, it might be opportune to show the obligations upon employers as regards employees going into service in the armed forces. On return to civil life, it is obligatory upon the employer to reinstate any employee in an occupation not less favourable and under similar conditions as to terms and so forth as would have been the case had the employee not left the employment to join the forces. These obligations apply under penalties which may be a fine not exceeding £50, and the payment of a sum of anything up to twelve weeks' wages or salary at pre-enlistment rates if not carried out. The employer, however, is not liable if, owing to a change of circumstances, it is not reasonably practicable to re-engage the employee, but a change of circumstances does not mean the substitution of some other person in the position formerly occupied by the employee concerned.

Furthermore, the requirement is fulfilled if the best position (and at terms and conditions not less favourable) is offered as is reasonably practicable at the relevant date.

To secure re-instatement, however, the employee must apply to the employer within one month after his service with the forces is terminated, and the employer is not liable if an engagement is offered and the employee does not re-enter employment at the time and place specified by the employer. These obligations apply to Reservists, Territorials or persons within the recent compulsory service Acts.

Where there is a contract of service or an apprenticeship entailing certain obligations, *e.g.*, remuneration, the performance or the provision of work, maintenance, or instruction) these are legally non-existent while the service of the employee is undertaken in the armed forces.

Another point to note is that it is an offence, with penalties, if the employer dismisses an employee in anticipation of his being called up and that the obligatory provisions will apply. As regards proceedings which may be instituted under this provision, the onus is upon the employer to prove that the dismissal occurred through some reason not connected with the fact that the employee was liable to be called up for service in the armed forces.

For High Quality Castings

The increasing demand for high-strength close-grained iron castings calls for improved metal. In comparison with the accepted standards of the past, the modern high quality casting requires lower total carbon and phosphorus, with a closer range in silicon. The Ironfounder can now meet this demand at a reasonable cost by the use of Stanton-Dale Refined Pig Iron.

Stanton-Dale is a pig iron of low total carbon, the graphitic carbon being uniformly distributed and of fine curly-flake formation. The close structure ensures remarkably high strength with good machineability, and Tensiles of 16 to 20 tons can readily be obtained when a proportion of Stanton-Dale Iron is introduced.

The use of this iron avoids the irregularities in structure which are sometimes observed when steel scrap has formed part of the charge.

The correct grade of Stanton-Dale Iron to use depends on the type and class of castings to be made. The Stanton Technical Service is available to advise on suitable mixtures.

Total Carbon from 2.6 per cent. upwards. *Analysis to individual specification as required.*

STANTON-DALE
REFINED PIG IRON

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

Patternmaking Examination Papers

In our issue of January 25 we printed the Foundry Practice and Science Examination Papers set by the City and Guilds of London Institute in 1939. Below are set out similarly the questions asked in connection with the Patternmaking Examination. The time allowed for each Paper was 3 hrs.

INTERMEDIATE EXAMINATION

First Paper—Patternmaking Practice

Attempt not more than FIVE *questions, of which it is recommended that one should be question* 1.

The maximum number of marks obtainable is affixed to each question. (This applies to all Papers.)

(1) Fig. 1 shows a section of a water-jacketed pipe. Sketch the core box required to make the outer core for the casting. (40 *marks.*)

(2) Describe the method of positioning the two cores for the casting shown in Fig. 1. (15 *marks.*)

(3) Cores may be used (*a*) because they are essential and (*b*) to simplify the moulding operation. Illustrate by means of sketches an example of each case. (15 *marks.*)

(4) Two pieces of timber are to be jointed and afterwards screwed together. Which of the two sketches A or B shown on Fig. 3 indicates the better method of jointing so as to ensure a permanent close joint, and what is the practical reason? (15 *marks.*)

(5) What are the advantages obtainable from the full-size lay-out of a pattern on a drawing board by a patternmaker? (15 *marks.*)

(6) Sketch a pin board and strickle provided to make the core for a three step pulley having a simple boss for the shaft. (15 *marks.*)

(7) Illustrate, by means of sketches, the method used to stop off some part of a mould made from a pattern which is longer than the casting required from it. (15 *marks.*)

(8) Sketch two examples of the use of a covering core to facilitate moulding or the removal of a loose piece on a pattern from the mould. (15 *marks.*)

(9) The mould for the casting shown in Fig. 2 may be struck up in either loam or dry sand. Sketch the strickle boards required for any one of these methods. (15 *marks.*)

(10) Illustrate by sketches three methods of location for cores to ensure their being in correct relationship to the mould. State when each method can be adopted. (15 *marks.*)

Second Paper—Drawing, Geometry and Calculations

Attempt not more than FIVE *questions, of which it is recommended that one shall be question* 1.

A pamphlet containing tables of logarithms and two sheets of drawing paper are to be given to each candidate. These must be inserted in his answer book before it is given up.

Drawing instruments should be used for questions 1, 4 *and* 6; *they may be used for question* 8, *but the sketches in answer to all other questions must be freehand.*

The use of a slide rule is permitted.

Reference must be made to Fig. 4 *for the figures referred to in the questions.*

(1) Draw, full size, three views as described below of the valve body illustrated on Fig. 4, and dimension them:—

(*a*) An elevation looking in the direction of arrow X.

(*b*) A half-plan looking in the direction of arrow Y.

(*c*) A half-section on CC looking in the direction of arrow Z. (40 *marks.*)

(2) Make a sketch of the pattern for the valve body casting shown on Fig. 4. (15 *marks.*)

(3) On a certain contraction rule the following symbols are to be found, viz.:—C. 1/120, A. 1/96, K. 1/64, and J. 1/77. Disregarding the letters, what rates of contraction per foot do the fractions indicate? (15 *marks.*)

(4) In elevation the axis of a cylinder 2½ in. dia. and 3 in. long makes an angle of 60 deg. to the horizontal plane. Draw this elevation and project from it a plan. (15 *marks.*)

(5) A solid pattern weighs 5 lbs. The metal of the casting made from it has a specific gravity 12 times that of the wood of the pattern. What is the weight of the casting if a cavity is made in the casting by a core 4 in. dia. and 4 in. long, 1 in. of which is core print? (Assume that 4 cub. in. of the metal weigh 1 lb.) (15 *marks.*)

(6) Draw the largest square you can in a 3-in. dia. circle. Calculate its area. (15 *marks.*)

(7) For a particular casting a loose pattern would cost £2 10s. and the castings from it 5s. each. A pattern-plate would cost £15, and the castings would then cost 3s. each. What is the smallest number of castings which would warrant the making of the pattern plates? (15 *marks.*)

(8) Make a dimensioned drawing or sketch of a suitable moulding box in which to make the valve body shown on Fig. 4. (15 *marks.*)

FINAL EXAMINATION

First Paper—Patternmaking Practice

Attempt not more than FIVE *questions, of which it is recommended that one shall be question* 1.

Two sheets of drawing paper to be given to each candidate. These must be inserted in his answer book before it is given up.

Reference must be made to Figs. 5 *and* 6 *for the figures referred to in the questions.*

(1) By means of sketches, indicate how the pattern for the casting, shown as Fig. 5, might be constructed. (40 *marks.*)

(2) Sketch the core box, or core boxes, required to complete the patternmaking requirements for the casting, shown as Fig. 5. (20 *marks.*)

(3) Illustrate, by means of sketches, the baseplate, spindle, spindle arm, strickles and gauge sticks required to strike up a typical loam mould. (20 *marks.*)

(4) Sketch an example of a pattern used with a stripping plate; describe briefly its usefulness and advantages. (20 *marks.*)

(5) Describe, with the aid of sketches, a metal mould for die-castings, showing how the parts of the die are secured during casting, and how loose plugs are positioned and removed. (20 *marks.*)

(6) Fig. 6 is an example of a pattern which could advantageously be mounted on follow boards. Show, by means of sketches, how this might be carried out, and describe briefly the benefits derivable from the method. (20 *marks.*)

(7) By means of sketches, illustrate two examples where the design of a casting makes it difficult to secure sound and satisfactory castings. Give an explanation of the defects to be

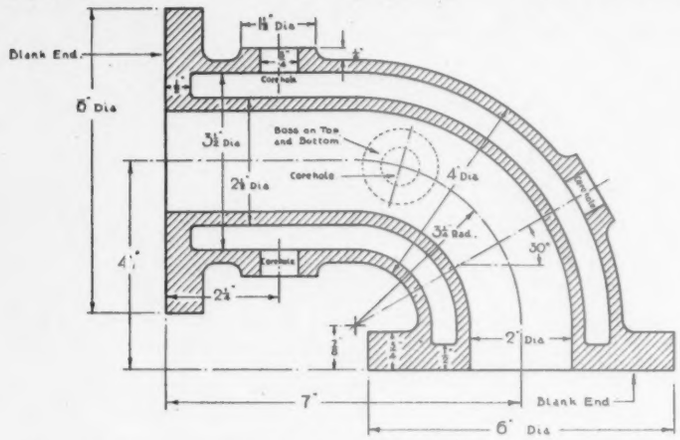


FIG 1

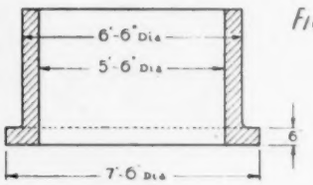


FIG 2

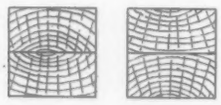
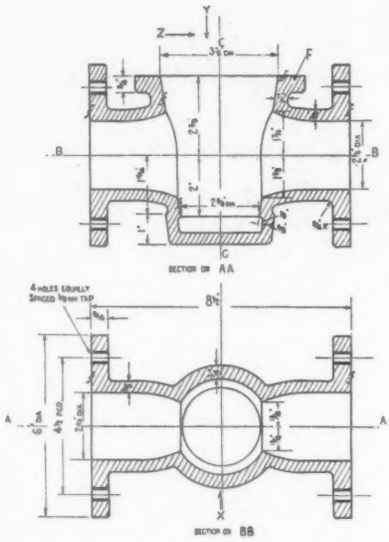


FIG 3



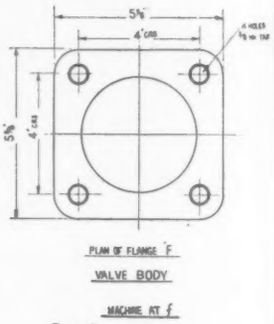
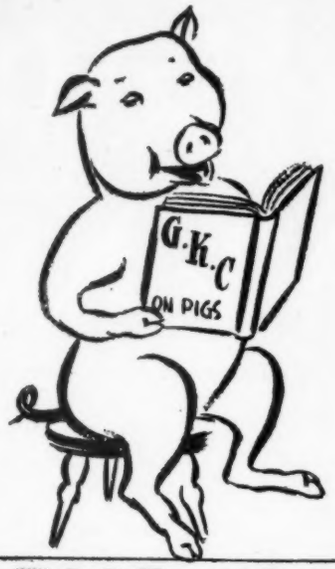


FIG. 4.



PIG TALE No. 4.

Chesterton on the Pig

We feared this title might require an illustration of the great G. K. C. careering around with flowing robe on a pig. Our Advertising Agents inform us, however, that there is no need to go to this expense. Chesterton, they tell us, wrote—not rode—on the pig in a highly diverting essay and even suggested they should be kept as pets because he considered them beautiful.

"Those who think otherwise," he wrote, "are those who do not look at anything with their own eyes. The actual lines of a pig are among the loveliest."

Our Advertising Agents may be excused for thinking that Chesterton had most certainly been looking with his own eyes at our pigs. After all we have many essays from customers to much the same effect.

At the same time we have grave doubts about having a pig for a pet. Having a pet pig is quite another matter, and is indulged in by the majority of Founders. Invariably, of course, it answers to the name of—

Warner's

WARNER AND CO., LTD.
CARGO FLEET
MIDDLESBROUGH-ON-TEES

expected and show how the design might be modified to assist the foundryman. (20 *marks.*)

Second Paper—Drawing and Geometry

Attempt not more than FOUR *questions, of which it is recommended that one shall be question* 1.

The answer to question 4 *should be carried out without the use of drawing instruments. In answering all other questions, except question* 4, *drawing instruments may be used.*

Two sheets of drawing paper to be given to each candidate. These must be inserted in his answer book before it is given up.

(1) The two pictorial views (Fig. 7) give sufficient information to permit an orthographic drawing of the object to be made. From these views draw a plan and two elevations of the casting. (40 *marks.*)

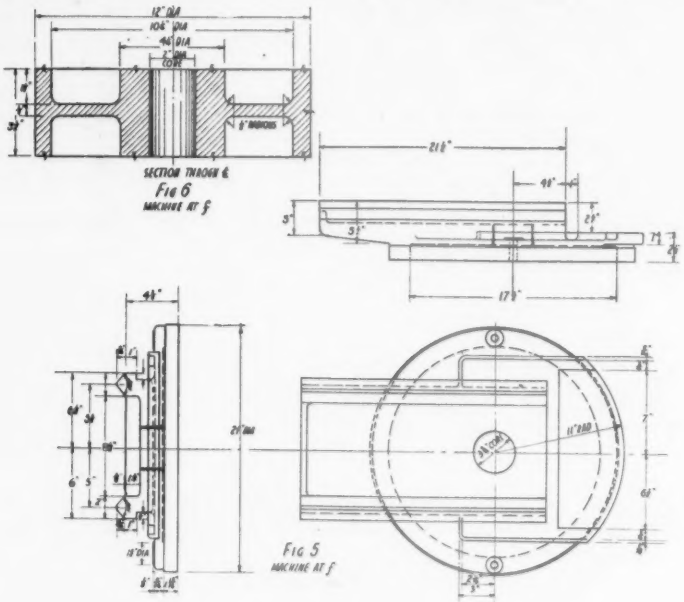
(2) A 3-in. dia. branch pipe is to be fitted against a 6-in. dia. body at right angles, the pattern being in halves. Show how you would lay out on a piece of paper, which is to be wrapped round a half branch, the outline of the fitted portion of the branch. (20 *marks.*)

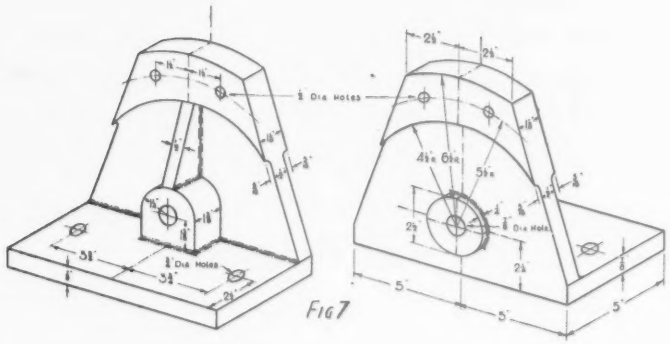
(3) A hexagonal prism, 2¼ in. across the flats, is to be cut at an angle of 45 deg. to its vertical axis. Project the shape exposed after the cutting. (20 *marks.*)

(4) Using the top of the table of a band saw as your base line, sketch the upper portion of the machine, illustrating clearly the details of the method of applying tension to the saw. (20 *marks.*)

(5) From the information supplied in the two elevations (Fig. 8) draw a full-size plan of the object looking in the direction of the arrow A. (20 *marks.*)

(6) Show, by means of sketches, a section of the mould for the casting, shown in Fig. 7, illustrating the arrangement of runners and risers. (20 *marks.*)





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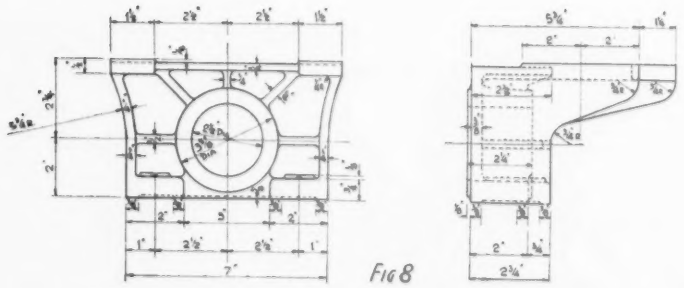


Reports and Dividends

Peter Brotherhood, Limited—Interim dividend of 8 per cent.

D. Napier & Son, Limited—Net profit for the year to September 30 last, £97,853; ordinary dividend of 7½ per cent.

Mather & Platt, Limited—Final ordinary dividend of 6 per cent., making 10 per cent. for the year ended December 31.

General Engineering Company (Radcliffe), Limited—Dividend of 10 per cent. for the year to November 30 last; net profit, £4,327.

Bertrams, Limited—Net profit for the year to September 30 last, £5,061; brought in, £2,166; dividend of 10 per cent., £2,925; carried forward, £1,831.

Weyburn Engineering Company, Limited—Net profit, after tax, £27,566; final ordinary dividend of 22½ per cent. and a bonus of 5 per cent., making 35 per cent. for the year ended October 31.

Shanks & Company, Limited—Profit for 1939 after tax, £52,387; brought in, £42,886; final ordinary dividend of 6 per cent., making 8½ per cent.; to war contingency fund, £10,000; carried forward, £55,959.

Vickers, Limited—Final dividends of 2½ per cent. on the preferred stock and the 5 per cent. preference stock, and 2½ per cent., free of tax, on the cumulative preference stock, making in each case 5 per cent. for the year ended December 31 last.

Dennis Bros., Limited—Profit for the year ended September 30, £120,059; brought in, £156,505; to special taxation reserve, £20,000; employees' benevolent fund, £2,000; interim dividend of 4d. per share, £25,041; final dividend of 10d. per share, £62,603; carried forward, £166,920.

Crosthwaite Furnaces & Scriven Machine Tools, Limited—Profit for 1939, after providing for depreciation, employees' bonus, taxation, and all other charges, £3,179; brought in, £3,139; dividend of 10 per cent., £2,448; to general reserve, £500; carried, forward, £3,370.

English Electric Company, Limited—Trading profit for 1939, £694,215; interest on 4 per cent. debenture stock, £48,312; depreciation, £75,000; reserve for taxation, £210,000; net profit, £355,656; brought in, £67,265; dividend on the preference stock, £53,830; dividend on the ordinary stock of 10 per cent., £192,251; to general reserve, £100,000; carried forward, £56,840.

Ingall, Parsons, Clive & Company, Limited—Profit for the year ending September 30, after providing £6,060 for upkeep and depreciation of buildings and plant, etc., £9,398; brought in, £13,609; preference dividend, £3,726; dividend on the ordinary shares of 10 per cent., £1,655; dividend on the deferred shares of 10 per cent., £1,421; to general reserve, £2,000; carried forward, £14,205.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1*s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.*

515,255. MEHTA, F. P. Dephosphorising of steel.

515,331. BIRMINGHAM ELECTRIC FURNACES, LIMITED, LOBLEY, A. G., and ROBIETTE, A. G. E. Annealing and other heat-treatment furnaces.

515,923. SMITH, R. L. H. Hardness-testing machines.

516,057. DEUTSCHE EISENWERKE AKT.-GES. Operation of cupola furnaces for the production of cast iron.

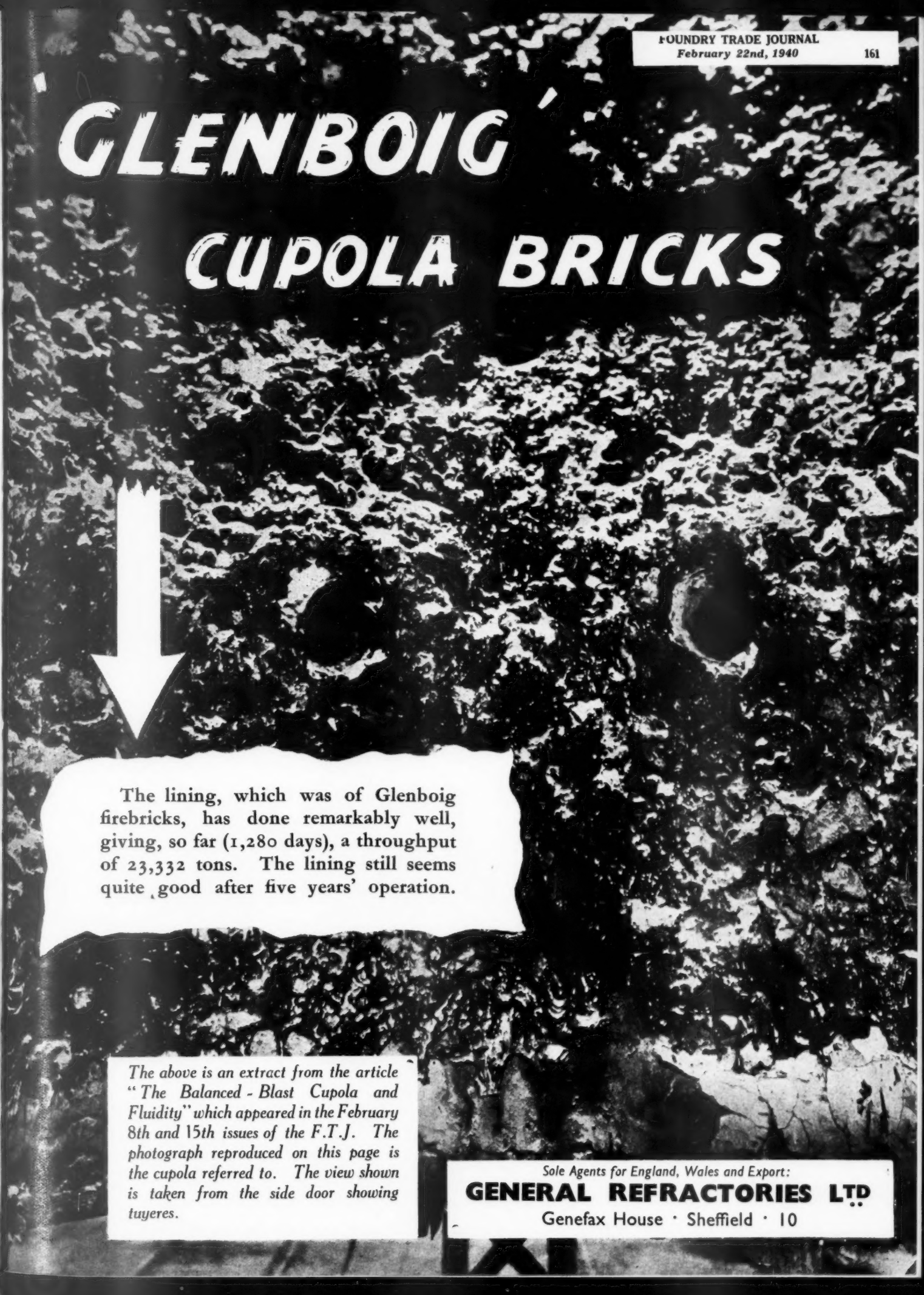
516,119. DEUTSCHE EISENWERKE AKT.-GES. Operation of cupola furnaces for the production of cast iron.

516,423. DIX, JUNR., E. H., and NOCK, JUNR., J. A. Heat-treatment of aluminium base alloys.

516,566. ASIATIC PETROLEUM COMPANY, LIMITED, and LUBBOCK, I. Production of gaseous atmospheres for use in the heat-treatment of metals.

516,661. EVANS, O. (Canadian Furnace, Limited). Apparatus for cooling and transporting hot iron pigs, steel billets, and the like.

GLENBOIG CUPOLA BRICKS



The lining, which was of Glenboig firebricks, has done remarkably well, giving, so far (1,280 days), a throughput of 23,332 tons. The lining still seems quite good after five years' operation.

The above is an extract from the article "The Balanced - Blast Cupola and Fluidity" which appeared in the February 8th and 15th issues of the F.T.J. The photograph reproduced on this page is the cupola referred to. The view shown is taken from the side door showing tuyeres.

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The Week's News in Brief

Trade Talk

THE FIRST annual staff dance of the Grahamston Iron Company, Limited, Falkirk, was an outstanding success, nearly 100 attending.

THE K.C.B. FOUNDRY COMPANY, LIMITED, is being wound up voluntarily. Mr. J. K. Carpenter, Faircross House, High Street, Watford, is the liquidator.

THREE MEMBERS of the staff of the British Cast Iron Research Association are now serving with the Forces. They are Mr. J. V. Chatterton, Mr. W. K. Greensmith and Mr. R. Rew.

ADAMS-HYDRAULICS, LIMITED, engineers and ironfounders, of York, have been elected members of the British Cast Iron Research Association. Mr. G. Kirk is to be their representative.

"WELDING AS A SUBSTITUTE FOR CASTING" was the title of a Paper presented by Dr. S. F. Dorey to members of the Institution of Engineers and Shipbuilders in Scotland, at a meeting in Glasgow last Tuesday.

THE TYNESIDE INDUSTRIAL DEVELOPMENT BOARD has received an inquiry from a London group regarding the possibility of reopening one of the idle shipyards on Tyneside. Jarrow Town Council is to urge the concern to give favourable consideration to the Jarrow yard.

BORAX & CHEMICALS, LIMITED, inform us that their main (temporary) offices will remove on Saturday next to Marlyn's House, Guildford, Surrey. The telephone number is Guildford 3327/8. The firm's offices in London and Liverpool will remain open to deal with urgent inquiries.

INDUSTRIAL EXPANSION at Witwatersrand, South Africa, has continued on an impressive scale since the beginning of the war. In Johannesburg alone many new factories are being built, including plants for general engineering. At Vereenging, on the Vaal River, the source of the goldfields' water supply, a new steel and ferro-alloy production plant will be started as soon as the international situation warrants it.

THE annual meeting of the Iron and Steel Trade Confederation's area council for the Siemens steel trade, representative of workers throughout South Wales, was held at Swansea on February 10. Following a report on negotiations in regard to the war bonus, it was agreed that the standing committee should pursue the matter further. It was also decided to submit a claim for £3 a week minimum wage for adult workers in the industry. It was resolved that a claim should be made for 20s. per shift instead of 10s. for second-hands watching melting furnaces on Sundays.

IT IS reported that the negotiations between the Brazilian Government and the United States Steel Corporation for the establishment of a large steel industry in Brazil have broken down. The Steel Corporation was proposing the provision of a capital of $30,000,000 for the development of Brazil's iron-ore resources and the erection of blast furnaces and steelworks. The failure to come to an agreement in the recent negotiations is put down to the present Brazilian law, which prohibits an undertaking of the size proposed to be under the control of foreign capital. Another difficulty is the lack of suitable technicians in Brazil.

A DISCUSSION on "Physics in the Glass Industry" took place under the auspices of the London and Home Counties Branch of the Institute of Physics last Thursday, at the Royal Institution, London. The meeting was presided over by Prof. W. S. Turner, O.B.E., F.Inst.P., F.R.S., and among the various aspects of the subject which received attention were "Physics in the Manufacture of Glass Bottles," by Dr. E. Seddon, F.Inst.P., and "Refractories used in the Glass Industry," by Dr. J. H. Partridge. The discussion proved of great value not only to industrial physicists engaged in the glass industry, but also to those in the many industries utilising glass and its products.

Synthetic Moulding Sands

MR. A. TIPPER, the author of the Paper bearing this title, printed in our issue of February 8, has pointed out to us that the reporting of the discussion printed on page 131 of the February 15 issue was faulty in two particulars. The word "glue," which appears on line 37, col. 1, should be "clay," whilst "reduced," appearing on line 26, col. 2, should read "produced." We regret these errors and thank Mr. Tipper for correcting them.

Obituary

MR. JAMES PHILIP, who was an ironmoulder with the Carron Company for 63 years, has died in Falkirk, aged 85 years. He was a Stenhousemuir "Wet Review" veteran.

MR. ERNEST MITCHELL, J.P., a director of Mitchell, Shackleton & Company, Limited, forgemasters, of Vulcan Works, Patricroft, Lancs, died on Thursday last in his 71st year. Some 40 years ago he joined with Mr. Edwin Shackleton in the foundation of the firm. Mr. Mitchell was a member of the Manchester Association of Engineers.

MR. JAMES MORTON, a retired ironfounder, died at his residence in Leven on Friday last. He was a son of the founder of Charlestown works, of which at one time he was sole partner. For many years ironfounding and engineering were conducted on an extensive scale there, large castings being shipped to all parts of the world.

MR. LEONARD WILSON HORTON, of Wolverhampton, died recently at the age of 65. Mr. Horton had been one of the directors of Manley & Regulas, Limited, since the inception of the company in 1919. For many years he was joint managing director of Horton & Son, bolt and nut manufacturers, Darlaston, until the business was sold to Guest Keen & Nettlefolds, Limited, in 1923.

MR. J. H. ATKINSON, secretary of the Bearpark Coal & Coke Company, Limited, Middlesbrough, died suddenly at Saltburn-by-the-Sea on February 14, in his 62nd year. He had been with the company for 47 years and had been secretary since 1914. Mr. Atkinson was widely known in coke trade circles.

MR. T. E. HOLGATE, who recently died at the age of 85 years, was a director of the Darwen & Mostyn Iron Company, Limited, with which company he was associated for 62 years. Mr. Holgate was educated at the Liverpool College and the Royal School of Mines, London, and was a pioneer in the manufacture of ferro-manganese in the blast furnace. He was also one of the oldest members of the Iron and Steel Institute and was actively interested in technical matters until the end. He performed many services to the town of Darwen over a long period in various public capacities, including the mayoralty, and particularly in the direction of education. In 1936, in recognition of his work and philanthropy, he was given the freedom of the borough.

Company Meeting

Westinghouse Brake & Signal Company, Limited

Presiding at the annual meeting of the Westinghouse Brake & Signal Company, Limited, held in London last week, LORD SOUTHBOROUGH (chairman) said that in the past five years the large participation of the company in the export trade had contributed greatly to their success, and it would readily be understood that disturbance of war must have substantial effects upon them. In September, all work on the Polish contract was brought to a halt. No contract had ever run more smoothly or had been carried out with greater good will on all sides. Up to and including the payments due in October, 1939, the Polish State Railways had met all payments which had become due, but, of course, the invasion of Poland and its disastrous consequences for that country created an entirely new situation for the Polish Government, and they were unable to make further payments under the contract. Under the Lithuanian contract all deliveries had been made and most of the payments received. The future of the export trade would depend to a great extent upon the assistance and support which the Government, through the new Export Council, could give to those interested. As to their trade in this country, they received certain cancellations of orders for brakes and signalling. On the other hand, they still had a number of contracts which were so far advanced that they would be completed. Railways and transport in general were vital elements, and certain orders for brakes, in particular, had come to them as a result of the war. The sales of Westinghouse metal rectifiers and rectifier equipment were affected. As to the future, the company was in a perfectly sound position. Their works were busy and were likely to remain so.

Personal

MR. C. W. REEVE has been appointed a managing director of D. Napier & Son, Limited.

MR. WILLIAM DENNY has been appointed manager of the engine works of William Denny & Bros., Limited, Dumbarton, in succession to the late Mr. W. J. Guthrie.

MR. HENRY P. HARLAND, a director of Harland & Wolff, Limited, the Belfast shipbuilding firm, has been returned unopposed to Parliament as Conservative Member for East Belfast.

COLONEL C. E. DAVIES, M.I.Mech.E., Secretary of the American Society of Mechanical Engineers, has been elected President of the Newcomen Society, which is devoted to the study of the history of technology.

MR. WILLIAM JOHNSTON, head shipping clerk with the Grahamston Iron Company, Falkirk, has taken up a similar position with the Lion Foundry Company, Limited, Kirkintilloch. He has been presented with a writing bureau by his former colleagues.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Midland Die Cast Products, Limited, Castle Works, Windsor Street, Birmingham—Capital £100.

Dupuy Gas Producers, Limited—Capital £1,000. Subscriber: L. Tobias, 8, Berdenshott Avenue, Richmond, Surrey.

H. Plowright & Sons, Limited—Capital £10,000. Agricultural engineers, etc. Directors: W. W. Wigg, "Highfield," Barnby, Beccles; H. E. Sanders.

F. & M. Supplies, Limited, 21/23, Coldharbour, Poplar, London, E.14—Capital £1,000. Foundry supplies. Directors: G. Millard and D. D. R. Watson.

Vivian Loyd & Company, Limited—Capital £10,000. Manufacturers of tractors, military and commercial cross-country machines, forgings, etc. Director: V. G. Loyd. Subscriber: G. Polaine, 19-21, Moorgate, London, E.C.2.

Contracts Open

London, S.W., February 28—Sewerage ironwork for 12 months from April 1, for the Merton and Morden Urban District Council. Mr. C. J. Mountfield, clerk, Dorset Hall, Kingston Road, Merton, London, S.W.19.

Rainford, March 9—Cast-iron goods for 12 months from April 1, for the Urban District Council. Mr. Geo. Walker, clerk, Council Offices, Rainford.

Rowley Regis, March 8—Cast-iron work, etc., for the year ending March 31, 1941, for the Corporation. Mr. Clifford Buckley, town clerk, Municipal Buildings, Old Hill, Staffs.

Shipley, March 1—Cast-iron pipes and specials for 12 months from April 1, for the Urban District Council. Mr. H. Dawson, surveyor, Town Hall, Shipley.

Forthcoming Events

FEBRUARY 23.

Manchester Association of Engineers:—"Development in Design of Boilers and Boiler-House Auxiliaries," Paper by A. Pollitt, at Engineers' Club, Manchester, at 7.15 p.m.

FEBRUARY 26.

Sheffield Society of Engineers and Metallurgists:—Biennial dinner, at the Royal Victoria Station Hotel, Sheffield, at 7 p.m.

MARCH 1.

Institution of Mechanical Engineers (Steam Group):—"Circulation of Water and Steam in Water-Tube Boilers, and the Rational Simplification of Boiler Design," Paper by W. Y. Lewis and S. A. Robertson, at Storey's Gate, London, S.W.1, at 6 p.m.

Institute of British Foundrymen

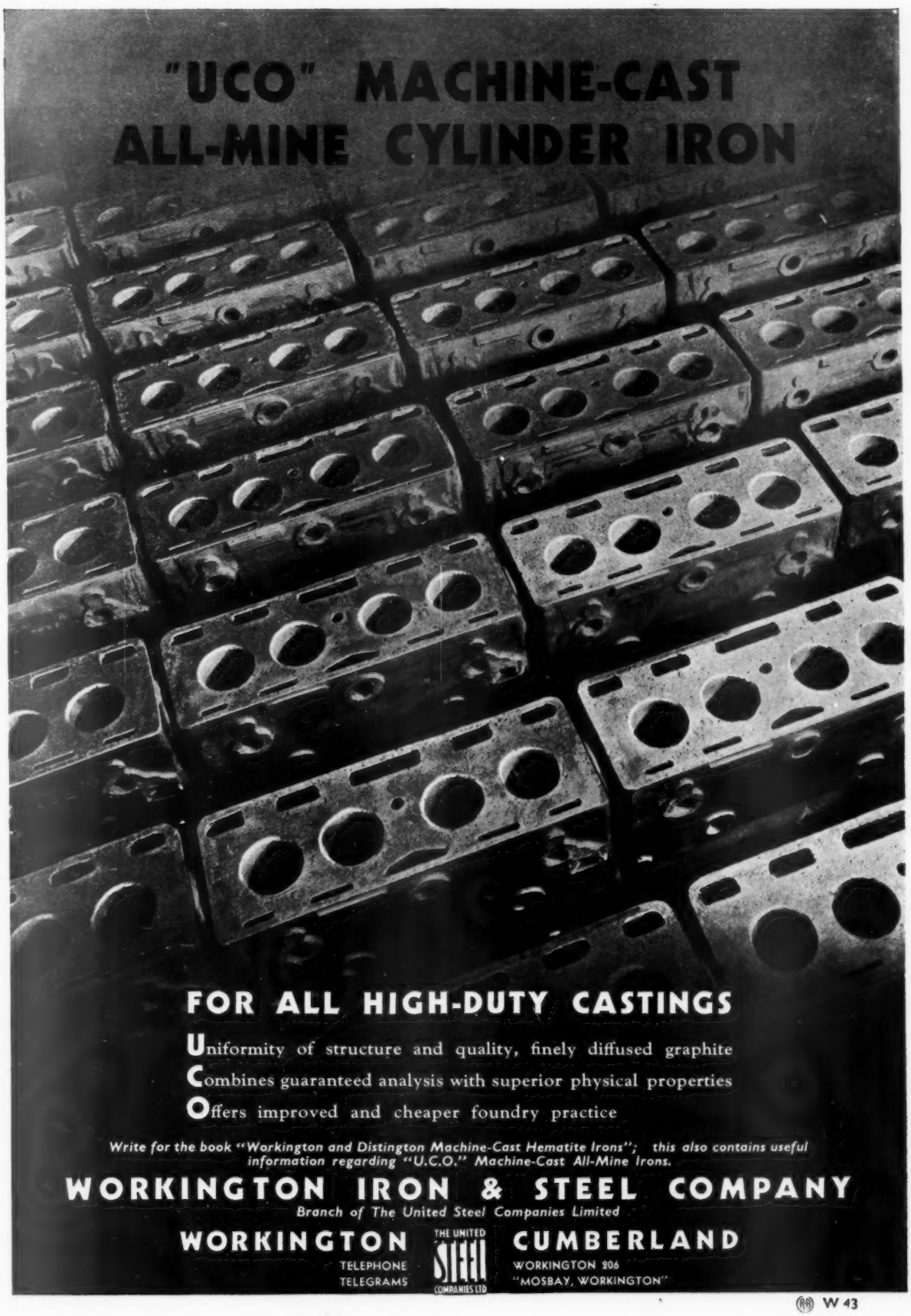
FEBRUARY 24.

Falkirk Section:—"Notes on the Production of Engineering Castings," Paper by A. Marshall, at Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

Middlesbrough Branch:—"Development of Steel-Foundry Production Methods," by C. J. Dadswell, at Darlington.

MARCH 2.

Lancashire Branch:—"Production of Some Engineering Castings," Paper by A. Marshall, at the Engineers' Club, Manchester, at 3 p.m.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ALL-MINE CYLINDER IRON
FOR ALL HIGH-DUTY CASTINGS
Uniformity of structure and quality, finely diffused graphite
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Raw Material Markets

It is anticipated in iron and steel circles that the special committee established by the President of the Board of Trade to advise on the export trade will give early consideration to the development, as far as possible, of shipments of iron and steel. This section of the industry could be expanded very considerably if the material were available, as the demand is undoubtedly very strong. Industrial concerns, while not wishing to jeopardise in any way the success of the defence programme, would be interested in any plan which allowed them to maintain contact with old-established customers abroad, while there is also the possibility of procuring new customers from among those now neglected by German concerns. Meanwhile, deliveries of iron and steel continue to be made to works in the United Kingdom at a brisk rate and the priority restrictions are unlikely to be relaxed for a considerable time.

Pig-Iron

MIDDLESBROUGH—Consumers of pig-iron are making heavy demands on the resources of blast furnaces in the Cleveland district, but good deliveries are reported and the difficult conditions brought about by the weather in the first month of the year appear to have been largely surmounted. Production of Cleveland foundry iron remains suspended, but adequate tonnages are forthcoming from the Midlands for users of this grade.

As far as hematite is concerned, large deliveries are being taken up, the recent price advance having made little or no difference to the demand. Producers have no large stocks on hand and buyers have to be content with week-to-week requirements. There is an increasing demand for the special qualities of hematite used by the makers of high-grade steel.

LANCASHIRE—The demand for foundry and forge grades of iron from the engineering speciality concerns continues to be insistent, while some other sections are now rather better placed. Business in textile machinery is not so satisfactory as might be wished, but makers are able to transfer part of their plant to the production of material required by the national defence programme. Both light and jobbing foundries are still operating on short time, but it is hoped that in the future there will be a larger amount of Government work available for these concerns.

MIDLANDS—Although many consumers of pig-iron would willingly take up additional supplies, it is appreciated that the Control authorities are distributing available material in an equitable manner, and there are few complaints in this respect. Consumers engaged on work of national importance are receiving first consideration in the distribution of supplies, but other concerns are also being given sufficient iron to enable them to operate at a reasonable level. As yet, no user is allowed to acquire stocks, but so long as proof is forthcoming that fresh supplies are required for early use little delay is experienced in obtaining deliveries. The furnaces are disposing readily of their total outputs. High-phosphorus iron is readily available, as many users are still working short time, especially the light foundries, the main users of this material. Heavy engineering concerns, on the other hand, together with many jobbing foundries, are very busy, and deliveries of low-phosphorus iron and hematite are large.

SCOTLAND—Consumers of foundry iron in this area are receiving satisfactory deliveries generally, although it cannot be said that there is any surplus. Variable conditions continue to prevail among the light-castings foundries in the Falkirk region; most of them, however, have insufficient work on hand to maintain full-time working, but with a few more Government contracts now being placed, there is some slight improvement to report. It is true to say that this branch is staking its future on the expansion of work of national importance, as there is unlikely to be much activity in the building trade for the duration of the war. Basic iron is in heavy request at the steelworks, and, fortunately, good shipments are arriving from abroad. Hematite, too, is in strong request, and the home production is quickly taken up.

Coke

Most of the larger consumers of foundry coke are in possession of fairly considerable stocks, which stood them in good stead during the freeze-up in the early part of the year. Deliveries are being made on a good scale, as users are anxious to keep their stocks at a high level. There is also, of course, the desire to buy while prices are at their present level, as the current quotations may be varied at any time by the Control authorities. For delivery to Birmingham and district, best coke from the Durham coalfield is quoted at 53s. per ton minimum.

Steel

The strength of the steel industry is fully maintained and, although outputs continue to be expanded, producers cannot attend as they would wish to the needs of the ordinary domestic trade and the export trade. The primary consideration, of course, is to meet in full the requirements of the Government's munitions programme, while shipbuilding is also accounting for large tonnages of finished steel. Steelmakers will supply civil needs where possible, but no firm delivery dates can be stipulated for such business. Re-rollers, in the Midlands especially, are shortly expected to be in a position to render greater assistance to the steelworks through the production of angles, tees, and other products.

Scrap

The suggestion is made in many parts that current prices of iron and steel scrap, which are fixed by the Control authorities, are uneconomic and should be raised at an early date. No official intimation is to hand, but it seems likely that the Control will shortly look into the matter. It is further suggested that more supplies of scrap would be forthcoming if prices were raised, but little credence is given to this in responsible circles. Scrap merchants rightly point out, however, that since the outbreak of the war their costs have increased substantially; for example, the costs involved in the preparation of scrap for the furnaces have been stepped up quite steeply, while transport costs, too, are higher than they were in peacetime. Imports are arriving steadily, but it hoped to increase the amount of foreign material entering the United Kingdom.

Metals

Chief interest in the tin market at the present time centres round the meeting of the International Tin Committee on Monday next, when the quotas for the second quarter of the year will be fixed. There is considerable conjecture as to the decision of the Committee, but a cut in the production to around 100 per cent. of standard tonnages, it would appear, is likely to be made, although some experts suggest a more severe reduction. The uncertainty of the position has naturally given rise to a fair amount of speculative interest in the market. It will be recalled that under the Anglo-Soviet trade agreement of last October, English tin was to be exchanged for Russian timber, but in the House of Commons recently the President of the Board of Trade stated that it had as yet been impossible to complete the exchange. Large exports of American tin had been made to the Soviet Union, but in view of the latter's aggressive policy, this has not proved popular in the United States either in trade circles or in sections of the Government.

Metal market prices for tin were as follow:—

Cash—Thursday, £241 5s. to £241 10s.; Friday, £240 15s. to £241; Monday, £242 to £242 5s.; Tuesday, £244 10s. to £244 15s.; Wednesday, £246 10s. to £246 15s.

Three Months—Thursday, £241 5s. to £241 10s.; Friday, £240 10s. to £240 15s.; Monday, £242 to £242 5s.; Tuesday, £244 5s. to £244 10s.; Wednesday, £246 5s. to £246 10s.

A feature of the copper trade recently has been the purchase by France of an additional 25,000 tons of United States copper at 11.50 cents, f.a.s. The Copper Institute reports production of crude metal in the United States during January as 89,861 short tons and of refined copper as 84,421 tons, while domestic deliveries were 91,428 tons. Exports of copper in January amounted to 17,037 tons, while stocks of refined metal at the end of January were 135,441 tons. Total production for the period August to December, 1939, has been corrected to 408,786 tons. The report of Union Minière du Haut-Katanga, the Belgian mining concern, states that copper production, after having been curtailed in the first half of 1939, was gradually increased as from August, and the total output for the year was 123,000 tons—approximately the same as the previous year's figure. There has been a substantial rise in selling prices since the outbreak of hostilities.

Although the substantial demand for spelter in connection with rearmament is appreciated, many ordinary users of the metal would welcome freer deliveries. Also with lead, there is a good demand outside of firms engaged on Government contracts. With the building trade virtually at a standstill, supplies of lead for other purposes are undoubtedly freer than they would otherwise be, as when building is normal, large tonnages of lead are used in house construction. According to the Building Industries National Council, the estimated value of work postponed or abandoned as the result of wartime administrative restriction is not less than £200,000,000 at pre-war prices.

The supply of non-ferrous scrap appears to fall short of demand, which is persistent from many directions. Some years ago a good deal of American scrap regularly crossed the Atlantic to this country, but the trade declined to small proportions. Now, however, it seems as if a start may be made again, and supplies of suitable old metal, both brass and copper, would be welcome, but it is perhaps doubtful whether these transactions will reach a large volume, for there is always the question of foreign exchange to be considered. Values of aluminium and light alloy scrap, which are decontrolled, have recently advanced rapidly, which suggests that demand has increased materially. The upper limits in brass and copper are, of course, fixed by the Ministry of Supply Order, so that inflation is prevented, but there is the fear that the scrap does not circulate so freely as could be wished.

Danish Iron and Steel Plans

Denmark is highly dependent on imports of iron, steel and other metals, which during recent years have averaged 10 per cent. of the country's entire import trade. As no raw materials for the production of iron and steel are found in Denmark, she is fully dependent on imported supplies; but about a quarter of the iron returns to the raw material market in the shape of scrap which, so far as cast iron is concerned, may be utilised by the Danish foundries. The position is a different one with regard to steel. Imports of steel amount to some 400,000 tons per annum, which with the lapse of time now gives rise to about 100,000 tons of steel scrap every year. This material can be utilised only partly in Denmark, as existing steelworks cannot handle more than 20,000 tons, the rest being exported. The problem has from time to time led to many proposals to make Denmark more independent. A big iron and steel works to be erected near Copenhagen was planned during the Great War 25 years ago, but initial as well as operating costs were found to be prohibitive. In recent years most efforts have been focussed on the production of pig-iron. A process by which pig-iron can be produced in rotating furnaces as a by-product in cement manufacture has been tried out for some years by F. L. Smidth & Company at their Aalborg works, proving a success. Regular production has started and is estimated to yield from 18,000 to 20,000 tons of iron a year. A scheme is under consideration for the erection of a large rolling mill so as to dispense with at least part of the present steel imports, which are practically confined to rolled products; the steel scrap available is to be used as a raw material and would require only a slight increase in fuel imports.

A.S.T.M. Specifications for Cast-Iron Pipe

The American Society for Testing Materials announces that tentative Specification No. A44, covering cast-iron pipe and specials, has been approved. It replaces an early one which has been in force for 35 years. A second specification to replace A74, dealing with cast-iron soil pipe and fittings, has similarly been approved.